Chapter 10: Energy Element

10.1 Vision Statement

"The Energy Element of the Comprehensive Plan serves to identify the energy infrastructure within our county and promote energy conservation measures that benefit our communities"

In order to develop a comprehensive community approach to energy conservation, it is essential to examine energy consumption at the local level. Commonly called an inventory of existing conditions, this section examines the diversity, availability and affordability of energy sources; local dependence on these sources; and the economic and environmental consequences of that dependence. Through this analysis, significant community issues associated with energy conservation can be identified, which will in turn facilitate the development of goals and objectives for the energy element.

To assess energy use, it is important to understand how energy is measured. Electricity is commonly measured in watts and watt-hours. While watts describe the rate at which energy is being consumed or produced at a given moment, watt-hours measure the total amount of energy consumed or produced over time. A kilowatt is equal to 1,000 watts and is used to describe the power use of appliances such as refrigerators and water heaters. One kilowatt hour (kWh) is 1,000 watts consumed or produced in one hour. Measuring the output of power plants requires larger measuring units such as the megawatt (equal to one million watts) and the gigawatt (equal to 1,000 megawatts).

Natural gas is measured either by volume (cubic feet) or by heat content (therms). When measured in terms of cubic feet, larger volumes of natural gas are measured in hundreds of cubic feet (Ccf) or thousands of cubic feet (Mcf). Natural gas companies have begun to switch to therms as the standard measurement because heat content is a more accurate way of quantifying amounts of natural gas. A therm is defined as 100,000 British thermal units (Btu).

To compare or add the energy consumed or produced by different energy sources, it is useful to convert to the energy industry's common unit, the Btu. One Btu represents the amount of energy required to increase the temperature of one pound of water (one pint) by one degree Fahrenheit. Because Btu measurement can be very large when discussing county-wide energy use, one million Btu (MMBtu) will be the common unit of measurement referenced throughout this document. Appendix B includes a listing of relevant energy conversion factors.

For individuals not employed in the energy industry, the concept of energy measurement can be difficult to fathom without comparisons to energy use in our everyday lives. Estimates of energy usage from the national perspective have been developed by the Energy Information Administration and agencies such as the California Energy Commission that help bring energy measurements into a practical perspective. According to such sources, the average single-family home (2.5 persons) in the United States uses approximately 110 MMBtu per year, while the average automobile carrying 1.1 occupants consumes 80 MMBtu per year. Annual per capita energy use nationwide is estimated to be 150 MMBtu. Total energy use per household, including travel, home energy use, and a proportional share of community non-residential and community infrastructure energy use is approximately 440 MMBtu.

10.2 State and National Energy Use Overview

The United States was self-sufficient in terms of energy until the late 1950s when energy consumption began to outpace domestic production. Since the late 1950s, the nation has imported more energy than it exported. According to the US Energy Information Administration (US EIA), the United States imported 30 quadrillion Btu and exported 4 quadrillion Btu of energy in 2001. Petroleum dominated energy imports by 1994, with the country importing more petroleum than it produces.

The transportation sector's energy use, which is overwhelmingly petroleum, more than tripled from 1949 to 2001. Motor gasoline accounts for about two-thirds of the petroleum consumed in the sector. Distillate

fuel oil (diesel engine fuel) and jet fuel are other leading petroleum products used in the transportation sector.

Most domestic energy consumed is derived from fossil fuels. Renewable energy resources – mostly hydroelectricity and the industrial use of biomass – have supplied a relatively small but steady energy source. In the late 1950s, nuclear fuel began to be used to generate electricity, and, by the late 1980s, nuclear energy contributed about the same share as renewable energy.

In South Carolina, nuclear energy accounts for nearly 33% of the State's energy consumption, markedly higher than the national level of only 7%. Consumption of nuclear energy in South Carolina rose by more than 172% in the 1990s. On a comparative level, nuclear energy accounted for more than half (56.5%) of all electricity generation in South Carolina in 2000, while accounting for less than one-fourth (23.5%) in the United States. As such, the State ranks third in the nation – behind only Pennsylvania and Illinois – in nuclear energy production for electricity generation.

Petroleum consumption accounts for nearly 28% of the State's energy use and coal for 24%, with natural gas comprising only 9.8% of statewide energy use. End-use deliveries of natural gas in South Carolina were 29.8% higher in 2000 than in 1980. Most of the increase occurred in the industrial sector, where natural gas deliveries increased by 28.7%. The industrial sector accounted for 64.3% of all natural gas deliveries in South Carolina in 2000, while accounting for 52.8% in the United States. Biofuels account for nearly 5% of the State's energy consumption.

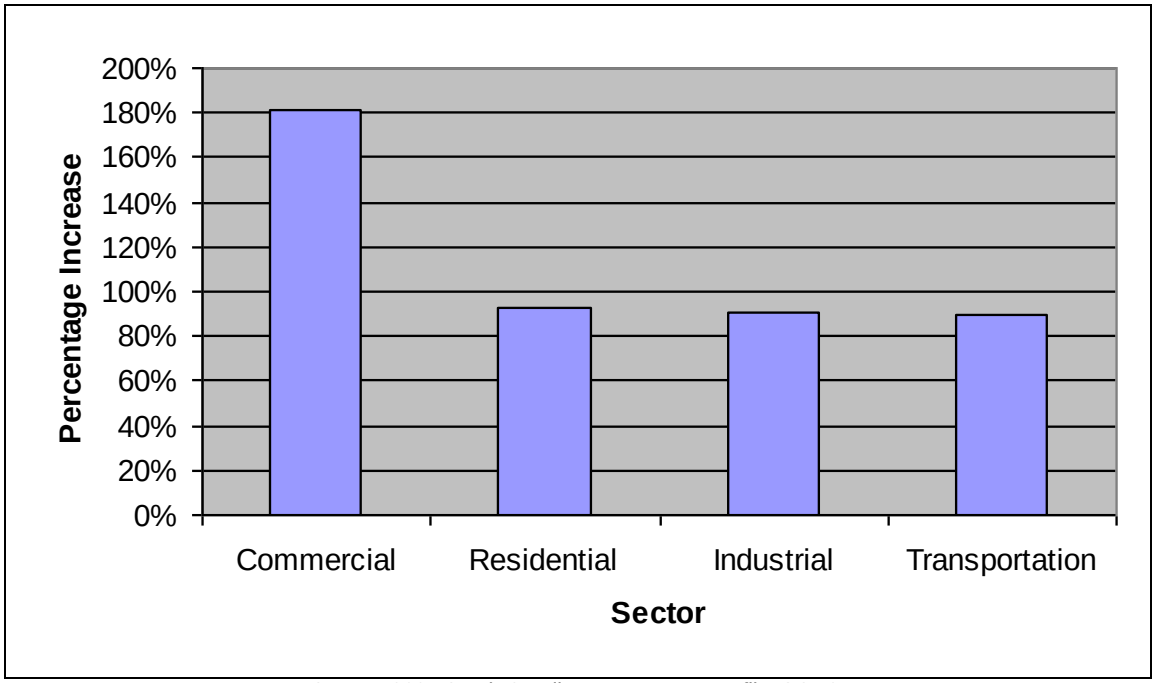
South Carolinians have long enjoyed energy on demand with some of the lowest prices in the nation – about 12% lower on average than the national average. However, residential electricity consumption in the State is far above the national average, resulting in average household utility bills that exceed the national average by more than 17%.

As the State's economy has grown, so too has its energy needs – with South Carolina ranking 19th in total per capita energy consumption nationwide. During the past three decades, statewide energy consumption increased at a much higher rate than the United States average. Total statewide energy consumption rose by 99.7% between 1970 and 1999, compared with an increase of only 40.8% nationwide during the same period.

The industrial sector accounts for more than 41% of the State's energy consumption. The SC Energy Office (SCEO) includes manufacturing industries, mining companies, construction companies, and agricultural, fishery and forestry operations in the industrial sector. Energy use in the transportation sector, including all private and public vehicles that move people and commodities, comprises more than 25% of statewide consumption. The residential sector includes all private residences whether occupied or vacant, owned or rented and accounts for 19% of the State's energy consumption. The remaining 14% of energy is consumed by the broadly defined commercial sector, which consists primarily of hotels, motels, restaurants, wholesale businesses, retail stores, laundries and other service enterprises, as well as religious and nonprofit organizations.

From 1970 to 1999, energy consumption in the State's commercial sector increased by nearly 181%, while industrial energy use rose by more than 90%. Residential energy consumption increased by nearly 93% and transportation use by almost 90% during the same time period.

Figure 10-1. Increase in Energy Consumption by Sector, 1970 – 1999
South Carolina



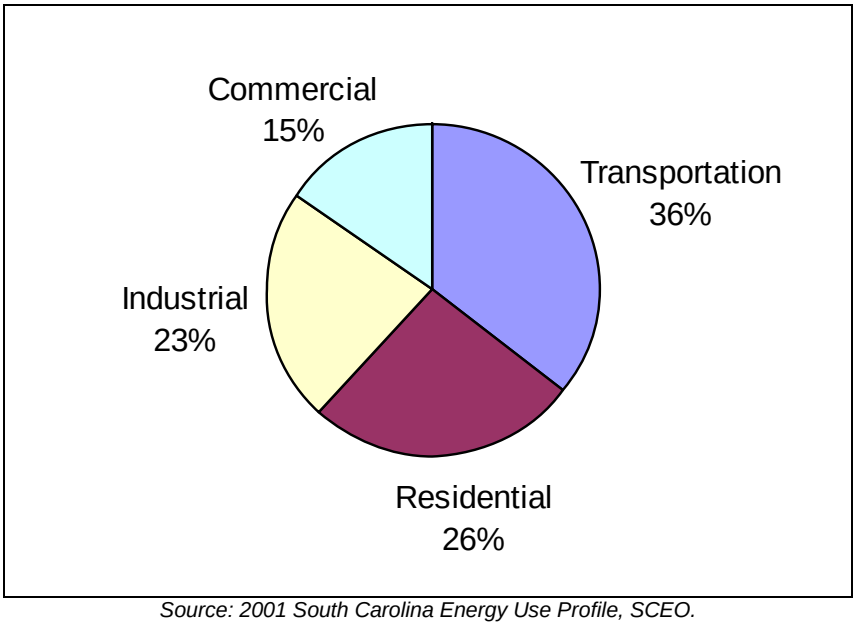
Source: 2001 South Carolina Energy Use Profile, SCEO.

Electricity accounts for nearly two-thirds (62.4%) of residential energy consumption in South Carolina, but only 36.4% on the national level. Twenty percent (20%) of residential energy is provided by natural gas, much lower than the 45% of residential energy nationwide provided by natural gas. Electricity provides 64% of energy used in the commercial sector in South Carolina, as compared with 49% in the United States. As in the residential sector, natural gas comprises 23% of commercial consumption statewide, while the national rate is much higher at 41%.

South Carolina ranks 19th nationally in industrial energy consumption. Unlike the residential and commercial sectors that rely primarily on electricity for energy, energy consumption in the industrial sector is more diversified. Twenty-seven percent of industrial energy is provided by electricity, 26.2% by natural gas, 18% by biofuels, 17% by petroleum, and 11.5% by coal.

South Carolina has electric rates which are slightly below the national average. Energy expenditures statewide have risen by 756% since 1970, while energy consumption increased by more than 99.7% during this time. South Carolinians spent $8.3 billion on energy in 1999. The transportation sector is responsible for the largest share of energy expenditures at 35.5%, followed by the residential sector at 26%, the industrial sector at 23% and the commercial sector at 15.4%.

Figure 10-2. Share of Energy Expenditures by Sector, 1999
South Carolina



Source: 2001 South Carolina Energy Use Profile, SCEO.

While near-term trends such as energy supply disruptions or political actions affect energy prices in the short term, long term trends are influenced primarily by fundamental issues including the availability of energy resources, emerging technologies, developments in domestic electricity markets and the impact of economic growth on projected energy demand. In its Annual Energy Outlook 2003, the US Energy Information Administration (EIA) reports that, as has been typical in recent years, energy prices were extremely volatile during 2002. Prices for natural gas rose from $2 per thousand cubic feet in January of 2002 to between $3 and $4 per thousand cubit feet by the fall. Crude oil prices also rose in 2002, from $16 per barrel at the first of the year to between $25 and $30 per barrel by the fall, mainly because of reduced production by the Organization of Petroleum Exporting Countries (OPEC) and, to a lesser degree, caution about potential military action in the Middle East. The EIA bases energy supply and price projections on long-term fundamentals in projecting energy prices in the coming years. They project average natural gas prices to drop form $4.12 per thousand cubic feet in 2001 to $2.75 per thousand cubic feet in 2002. After 2002, natural gas prices are projected to move higher as technology improvements prove inadequate to offset the impacts of resource depletion and increased demand. The EIA projects that average electricity prices will decline from 7.3 cents per kilowatt hour in 2001 to a low of 6.3 cents (2001 dollars) by 2007 as a result of cost reductions in an increasingly competitive market. These projections anticipated an excess generating capacity that resulted in a construction boom and a continued decline in oil prices. Beginning in 2008, average electricity prices are projected to increase by 0.4% each year as a result of rising natural gas prices and a growing need for new generating capacity to meet growth in electricity demand.

Automotive fuel prices fluctuated widely both in South Carolina and nationally in 2002 and early 2003, with gasoline prices in February of 2003 averaging more than 50 cents per gallon higher than a year earlier. Reasons for fluctuations in prices include unrest in resource rich mid-eastern countries, strikes by Venezuelan petroleum workers, and a wavering economy here in the United States. While it is difficult to make accurate predictions about future gasoline prices given the number of factors involved, dependence on imported supplies increases the likelihood that fuel prices will continue to fluctuate well into the future.

10.3 Inventory of Local Energy Sources and Costs

A key component in an effective and relevant energy conservation plan is a comprehensive assessment of the energy sources used in Greenwood County as well as the costs associated with these uses. Factors such as the diversity of energy sources, energy source use within economic sectors, and the geographic origin of local energy supplies provide baseline information that can be used both to analyze current conditions and to make projections of future energy use. An examination of local dependence on

nonrenewable resources and the possible adverse affects of some energy sources will provide greater insight into future avenues for energy conservation in Greenwood County.

10.3.1 Energy Supply Mix and Cost

Data obtained from Greenwood County energy providers – including the Greenwood Commissioners of Public Works (GWCPW), Duke Power Company, Little River Electric Cooperative, Greenwood Petroleum and Stockman Oil – indicates energy customers in Greenwood County consume more than 9.7 million MMBtu per year, excluding transportation fuels. Nearly 58% of the energy distributed in Greenwood County comes from electricity, at a cost of more than $73 million a year. The bulk of the remainder of the energy distributed within the County (42%) comes from natural gas, at a cost of more than $30.7 million. Energy in the form of fuel oil and kerosene represent small shares of the County energy market. Greenwood County consumers spend more than $104 million annually on energy. Fuel costs average $10.74 per MMBtu. The costliest energy source is electricity at $13.03 per MMBtu. Kerosene follows at $10.24 per MMBtu and fuel oil at $8.15 per MMBtu. Natural gas is Greenwood County's least costly energy source at only $7.60 per MMBtu.

Figure 10-3. Total Energy Distribution by Energy Type, 2001
Greenwood County

Energy Type	MMBtu	% Total MMBtu	Total Cost	Cost per MMBtu
Electricity	5,626,166.2	*57.9%*	$73,281,935	$13.03
Natural Gas	4,042,145.4	*41.6%*	$30,701,662	$7.60
Fuel Oil	38,125.9	*0.4%*	$310,820	$8.15
Kerosene	11,697.9	*0.1%*	$119,750	$10.24
Total	**9,718,135.4**	***100.0%***	**$104,414,167**	**$10.74**

10.3.1.1 Residential

Consumers in Greenwood County's residential sector use 2.27 million MMBtu of energy each year, at a total cost of more than $33.6 million. Much of this energy is in the form of electricity, accounting for nearly 60% of total energy distribution. Natural gas provides much of the remainder of energy for residential consumers at 39%, with fuel oil and kerosene each providing less than 1% of total residential energy.

In 2001, residential customers in Greenwood County paid $14.82 per MMBtu for energy of all types, with a total energy cost of more than $33.6 million per year. Electricity is the most expensive energy source for residential customers at $16.95 per MMBtu, with a total cost per year of more than $23 million. Consumers in the residential sector paid $11.74 per MMBtu for natural gas at a total cost of more than $10.3 million annually. Cost per MMBtu in the residential sector is lower for fuel oil and kerosene, at $8.65 and $10.28, respectively.

Figure 10-4. Residential Energy Distribution by Energy Type, 2001
Greenwood County

Energy Type	MMBtu	% Total MMBtu	Cost	Cost per MMBtu
Electricity	1,357,689.6	*59.8%*	$23,010,288	$16.95
Natural Gas	885,530.1	*39.0%*	$10,393,296	$11.74
Fuel Oil	15,852.3	*0.7%*	$137,160	$8.65
Kerosene	11,157.9	*0.5%*	$114,750	$10.28
Total	**2,270,229.9**	***100.0%***	**$33,655,494**	**$14.82**

10.3.1.2 Commercial

Nearly 1.4 million MMBtu of energy is used by the commercial sector in Greenwood County annually. The County's commercial sector includes agricultural and institutional (government and schools) energy uses. More than half of this energy (51.6%) comes from electricity and 47% from natural gas. Fuel oil

accounts for 1% of energy and kerosene provides a very small fraction (only 540 MMBtu) of energy in the commercial sector.

Commercial energy consumers pay $13.60 per MMBtu in Greenwood County, with a total energy cost of more than $18.9 million a year. Electricity is the most expensive source at $16.72 per MMBtu, with a total cost per year of more than $12 million. Commercial customers pay $10.31 per MMBtu for natural gas, with a total per year cost of nearly $6.8 million. Only $5,000 is spent on kerosene in the commercial sector yearly, at a cost of $9.26 per MMBtu. Fuel oil is the least expensive energy source at only $7.93 per MMBtu, with a total of $110,660 spent annually.

Figure 10-5. Commercial Energy Distribution by Energy Type, 2001
Greenwood County

Energy Type	MMBtu	% Total MMBtu	Cost	Cost per MMBtu
Electricity	718,435.7	*51.6%*	$12,014,625	$16.72
Natural Gas	658,787.0	*47.3%*	$6,794,009	$10.31
Fuel Oil	13,952.2	*1.0%*	$110,660	$7.93
Kerosene	540.0	*0.0%*	$5,000	$9.26
Total	**1,391,714.9**	***100.0%***	**$18,924,294**	**$13.60**

10.3.1.3 Industrial

More than 6 million MMBtu of energy is used by Greenwood industrial consumers each year. Nearly 59% of this industrial energy comes from electricity, while more than 41% is generated by natural gas. Only 8,321 MMBtu of energy is generated by fuel oil in the industrial sector and no kerosene is used for industrial purposes in the County.

Greenwood County industrial consumers expend an average of $8.56 per MMBtu, with a total energy cost of more than $51.8 million a year. Electricity is the most costly energy source for industrial customers at $10.78 per MMBtu, with a total cost of more than $38 million annually. Natural gas customers pay $5.42 per MMBtu, with a yearly cost of more than $13.5 million. The small percentage of customers (less than 1%) using fuel oil pay $7.57 per MMBtu.

It is important to note that due to larger quantities used, industrial energy consumers in Greenwood County pay substantially less per MMBtu for energy than residential and commercial customers. Overall energy costs were $5 or more per MMBtu for residential and commercial customers and more than $6 for residential and commercial electricity customers. Natural gas consumers in the industrial sector pay $6.33 less than residential consumers and $4.90 less than consumers in the commercial sector.

Figure 10-6. Industrial Energy Distribution by Energy Type, 2001
Greenwood County

Energy Type	MMBtu	% Total MMBtu	Cost	Cost per MMBtu
Electricity	3,550,041.1	*58.6%*	$38,257,022	$10.78
Natural Gas	2,497,828.3	*41.2%*	$13,514,357	$5.41
Fuel Oil	8,321.4	*0.1%*	$63,000	$7.57
Kerosene	0.0	*0.0%*	$0	$0.00
Total	**6,056,190.8**	***100.0%***	**$51,834,379**	**$8.56**

10.3.2 Energy Sources

The Greenwood Commissioners of Public Works (CPW) provides electricity to customers within the City of Greenwood. Duke Power Company is the primary electricity provider for the unincorporated area of Greenwood County outside of the City of Greenwood, with Little River Electric Cooperative distributing electricity to customers in limited areas along the Greenwood and Abbeville County border.

Nearly 84% of the total electricity distributed in Greenwood County is from Duke Power Company. Greenwood CPW provides more than 16% of the electricity in the County, with the remainder (less than 1%) provided by the Little River Electric Cooperative. Greenwood CPW also provides natural gas to all Greenwood County consumers. Greenwood Petroleum provides 78% of all kerosene and all fuel oil distributed in Greenwood County, while Stockman Oil provides 22% of the kerosene sold in the County.

Figure 10-7. Energy Distribution by Energy Type and Provider, 2001
Greenwood County

Source/Provider	MMBtu	% of MMBtu
Electricity	5,626,166.2	57.9%
Duke Power	*4,703,714.8*	*83.6%*
GWCPW	*922,252.7*	*16.4%*
Little River	*198.7*	*0.0%*
Natural Gas	4,042,145.4	41.6%
GWCPW	*4,042,145.4*	*100.0%*
Fuel Oil	38,125.9	0.4%
GW Petroleum	*38,125.9*	*100.0%*
Kerosene	11,697.9	0.1%
GW Petroleum	*9,180.0*	*78.5%*
Stockman Oil	*2,517.9*	*21.5%*
Total	**9,718,135.4**	**100.0%**

10.3.2.1 Electricity

The City of Greenwood established the Commissioners of Public Works (CPW) in 1896 to provide electrical and water service to City residents. CPW is publicly owned and is governed by a three member Board of Commissioners. The Greenwood CPW Electric Distribution System provides power to more than 10,000 customers. The System includes 5 substations and approximately 180 miles of line. Greenwood CPW purchases its electricity from two sources – South Carolina Electric and Gas (SCE&G) and the Southeastern Power Administration. CPW obtains the majority of its energy (approximately 95%) from SCE&G, and the remainder from the Southeastern Power Administration.

SCE&G, a principal subsidiary of the investor-owned SCANA Corporation, provides electricity to more than 547,000 retail and wholesale customers in South Carolina. Fossil fuels, hydroelectric, nuclear and internal combustion technologies generate electricity at 21 SCE&G facilities. SCE&G uses coal to generate 75% of its electricity, with nuclear energy generating nearly 21% of its electricity and the remainder generated by hydroelectric facilities. The company operates 18 power plants – with 8 plants located in the Midlands Region (Richland, Lexington and Fairfield Counties), 2 plants in Aiken and Charleston Counties, and additional plants in Anderson, Beaufort, Colleton, Jasper, Orangeburg and Union Counties. Located northwest of the City of Columbia in Fairfield County near Jenkinsville, the SCE&G Virgil C. Summer Nuclear Station has a generating capacity of 953.9 megawatts.

As part of the US Department of Energy, the Southeastern Power Administration, markets electric power and energy generated by the Federal reservoir projects (hydroelectric) operated by the US Army Corps of Engineers to public bodies and cooperatives in the states of West Virginia, Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Tennessee, and Kentucky. Their customers include 127 electric cooperatives and 176 public bodies, ultimately serving 18 million retail customers through their wholesale customers. The total generating capacity of the Southeastern Power Administration is 3,092 megawatts.

Duke Power Company is an investor-owned utility company that serves more than 2 million customers within its 22,000 square mile service area in central and western North Carolina and South Carolina. More than one-fourth (667,000) of Duke Power's customers are in South Carolina. The Company

operates 8 coal-fired stations, 3 nuclear stations, 31 hydroelectric stations, and numerous turbine units fueled by natural gas or fuel oil. More than half (51%) of Duke Power's electricity is generated by coal, oil and gas with 48% produced by nuclear energy. Duke Power produces much of the electricity for Greenwood County at its Oconee Nuclear Station, located on the shores of Lake Keowee in Oconee County. The Oconee Station operates 3 units with a total capacity of 2,538 megawatts. To date, the Oconee Nuclear Station has produced more electricity than any other US nuclear station. Electricity for Greenwood County customers is also produced at Duke Power's Buzzard Roost Plant in Greenwood County. The Buzzard Roost Plant operates 10 combustion turbine (gas) units, with a total capacity of 196 megawatts.

The Little River Electric Cooperative is a member-owned rural electric cooperative based in the nearby City of Abbeville. Little River provides service to more than 12,500 residential, commercial and industrial customers in Abbeville, Anderson, Greenwood and McCormick Counties. The Cooperative purchases electricity from Duke Power.

10.3.2.2 Natural Gas

Greenwood CPW is the natural gas provider in Greenwood County. The Natural Gas Unit began operation in 1940, initially serving only customers within the City of Greenwood. In 1946, the natural gas system became a part of the combined public works system that is now called the Commissioners of Public Works (CPW). Today CPW provides natural gas within a territory of 310 square miles that extends from the Town of Chappells to the City of Belton. In addition to the City of Greenwood, CPW is the natural gas supplier to the Towns of Donalds, Hodges, Ware Shoals and Ninety Six. The CPW natural gas system has approximately 75 miles of high pressure transmission mains and 560 miles of distribution lines.

The CPW system has interconnections with two interstate pipelines – the Transcontinental Gas Pipe Line and the South Carolina Pipeline Company (SCPC). Greenwood CPW purchases nearly all of its natural gas from Trans-Continental Pipeline, a subsidiary of Williams Energy, and a small amount from South Carolina Pipeline, a subsidiary of SCANA. Transcontinental is one of the largest natural gas producers in the nation, providing interstate natural gas transportation, primarily via pipeline, from the Gulf Coast to markets in eastern and southeastern states. SCPC pioneered the expansion of safe and cost-effective gas service into much of South Carolina beginning in the 1950s and has expanded its facilities to include nearly 2,000 miles of pipelines serving 40 of South Carolina's 46 counties.

10.3.2.3 Gasoline

While there are no gasoline production facilities or refineries in South Carolina, two major petroleum pipelines traverse the State, both through the upstate region. Colonial Pipeline Company and Plantation Pipeline Company, both based in Atlanta, are the owners and operators of the pipelines. Colonial Pipeline distributes an average of 95 million gallons of gasoline, diesel fuel, home heating oil, aviation fuel and military fuels through its 5,519 mile system. An average of 600,000 barrels of petroleum products are distributed through the 3,100 mile Plantation Pipeline system daily. Products distributed by both companies originate in Texas, Louisiana, Mississippi and Alabama. Gasoline for Greenwood County is transported to terminals in Belton, North Augusta and Spartanburg, where it is distributed via truck to public and private distributors in the area.

10.3.2.4 Other Fuels

Greenwood Petroleum is the major distributor of commercial and home fuel oil in Greenwood County and provides more than three quarters (78.5%) of the kerosene sold in the County. The Company has served customers in Greenwood, Abbeville, Laurens and Saluda Counties since 1914. Greenwood Petroleum purchases fuel oil and kerosene from the British Petroleum Company (BP).

Stockman Oil provides 22.5% of the kerosene for Greenwood County consumers. Founded in 1932, the Company is a petroleum distributor, offering fuel, gasoline and lubricant products. Stockman Oil purchases its petroleum supplies from Castrol, Citgo, Exxon, Mobil, Shell and Texaco. The company has warehouse locations in Greenwood and in Elberton and Lithonia, Georgia.

10.3.3 Energy Source Use Per Sector

Additional information on energy consumption can be gathered through closer examination of the types of energy used within each economic sector. Such analysis does not include transportation fuel consumption, which includes all types of transportation regardless of the economic sector served. The industrial sector is by far the largest consumer of energy in Greenwood County at 62.3%. The residential sector accounts for 23.4% and the commercial sector 14.3% of energy consumption within the County.

In 2001, residential customers paid an average of $14.82 per MMBtu for energy, while commercial customers paid $13.60 per MMBtu. The average energy cost is $5 less per MMBtu for industrial customers at only $8.56 per MMBtu. Even with a lower energy rate, industrial consumers collectively pay more than half of the total energy expenditures for all sectors at more than $51 million.

Figure 10-8. Total Energy Distribution by Sector in Greenwood County, 2001

	Energy Distributed per Sector		Energy Cost	
Sector	**MMBtu**	**% MMBtu**	**Total**	**Per MMBtu**
Residential	2,270,229.8	*23.4%*	$33,655,493	$14.82
Commercial	1,391,714.7	*14.3%*	$18,924,294	$13.60
Industrial	6,056,190.9	*62.3%*	$51,834,379	$8.56
Total	**9,718,135.4**	***100.0%***	**$104,414,166**	**$10.74**

Electricity distributed to all economic sectors totals more than 5.6 million MMBtu per year. The industrial sector is also the largest user of electricity, purchasing more than 63% of the total energy generated by electricity for Greenwood County consumers. Nearly one-fourth (24%) of electricity is distributed to residential customers and 13% to the commercial sector.

While the industrial sector accounts for more than half (52%) of the total cost of electricity in the County, industrial users pay the least per MMBtu at $10.78. Residential and commercial customers pay substantially more per MMBtu for their electricity at nearly $17.

Figure 10-9. Electricity Distribution by Sector in Greenwood County, 2001

	Amount Distributed per Sector			Cost	
Sector	**kWh**	**MMBtu**	**% MMBtu**	**Total**	**per MMBtu**
Residential	397,799,411	1,357,689.6	*24.1%*	$23,010,288	$16.95
Commercial	210,499,713	718,435.7	*12.8%*	$12,014,625	$16.72
Industrial	1,040,152,724	3,550,041.1	*63.1%*	$38,257,022	$10.78
Total	**1,648,451,848**	**5,626,166.4**	***100.0%***	**$73,281,935**	**$13.03**

More than four million MMBtu of energy produced by natural gas is distributed annually in Greenwood County. Nearly 62% of the natural gas energy distributed in the County is for the industrial sector. Residential use accounts for 22% of natural gas distribution and approximately 16% is distributed to the commercial sector.

The total cost of natural gas was highest in the industrial sector. However, industrial users paid the least per MMBtu for energy at $5.41. Residential customers paid more than twice that rate at $11.74 per MMBtu, while commercial customers paid just a little less than twice the industrial rate at $10.31 per MMBtu.

Figure 10-10. Natural Gas Distribution by Sector in Greenwood County, 2001

Sector	Amount Distributed per Sector			Cost	
	Mcf	MMBtu	% MMBtu	Total	per MMBtu
Residential	859,738	885,530.1	*21.9%*	$10,393,296	$11.74
Commercial	639,599	658,787.0	*16.3%*	$6,794,009	$10.31
Industrial	2,425,076	2,497,828.3	*61.8%*	$13,514,357	$ 5.41
Total	**3,924,413**	**4,042,145.4**	***100.0%***	**$30,701,662**	**$ 7.60**

Energy produced by fuel oil for all economic sectors in Greenwood County totals 38,126 MMBtu per year. Nearly 42% of fuel oil is distributed to residential consumers, 36% to commercial customers, and 22% to industrial consumers. Prices for fuel oil average $8.15 per MMBtu for all sectors, with residential customers paying slightly more at $8.65 per MMBtu. Prices are lower for commercial and industrial customers at $7.93 and $7.57, respectively.

Figure 10-11. Fuel Oil Distribution by Sector in Greenwood County, 2001

Sector	Amount Distributed per Sector			Cost	
	Gallons	MMBtu	% MMBtu	Total	per MMBtu
Residential	114,300	15,852.3	*41.6%*	$137,160	$8.65
Commercial	100,600	13,952.2	*36.6%*	$110,660	$7.93
Industrial	60,000	8,321.4	*21.8%*	$63,000	$7.57
Total	**274,900**	**38,125.9**	***100.0%***	**$310,820**	**$8.15**

Only 11,698 MMBtu of energy produced by kerosene is distributed each year in Greenwood County to consumers in the residential and commercial sectors. Nearly all of the kerosene distributed in the County (95.4%) is used by the residential sector, with only 4.6% distributed to the commercial sector. No kerosene is used by the County's industrial sector. Kerosene consumers pay an average of $10.24 per MMBtu. Residential kerosene users pay $10.28 per MMBtu and commercial consumers pay slightly less at $9.26 per MMBtu.

It is important to note that kerosene consumption in South Carolina gradually declined over the past 20 years, experiencing a 50.8% drop from 1980 to 2000.

Figure 10-12. Kerosene Distribution by Sector in Greenwood County, 2001

Sector	Amount Distributed per Sector			Cost	
	Gallons	MMBtu	% MMBtu	Total	per MMBtu
Residential	82,651	11,157.9	*95.4%*	$114,750	$10.28
Commercial	4,000	540.0	*4.6%*	$5,000	$ 9.26
Industrial	0	0.0	*0.0%*	$0	$ 0.00
Total	**86,651**	**11,697.9**	***100.0%***	**$119,750**	**$10.24**

10.3.4 Summary of Energy Sources and Prices

Electricity is the most prominent energy source for Greenwood County consumers, comprising 58% of total energy distributed. Natural gas follows closely, providing 42% of the County energy distribution. Electricity provides more than half of the energy used within the residential, commercial and industrial sectors. Natural gas is close behind, providing 40% of residential and industrial energy and 47% of commercial energy.

Duke Power Company provides nearly 84% of the electricity distributed within Greenwood County. Duke generates its own electricity, with 51% generated through nuclear energy and 48% from coal, oil and gas. The Greenwood area is served primarily by the Oconee nuclear station in Oconee County and the Buzzard's Roost facility (a combustion turbine/gas unit) located in Greenwood County.

The Little River Electric Cooperative serves a small percentage of Greenwood County electric customers located near the Abbeville County border. Little River purchases its electricity from Duke Power.

Greenwood CPW provides more than 16% of the electricity distributed in Greenwood County. CPW purchases most of its electricity from SCE&G and a small percentage from the Southeastern Power Administration. SCE&G generates its electricity, with 75% produced by coal and 21% by nuclear power, with a small percentage generated by hydroelectric facilities. The Southeastern Power Administration sells hydroelectric power generated at federal facilities around the country to local governments and cooperatives.

Greenwood CPW is also the sole provider of natural gas within the County. CPW purchases nearly all of its natural gas from Transcontinental Pipeline and a small amount from South Carolina Pipeline.

Transportation fuels are transported to terminals in Belton, North Augusta and Spartanburg from the Plantation Pipeline and the Colonial Pipeline. Both pipelines traverse the State in the upstate region, and both companies are based in Atlanta. The fuel is transported via truck from the terminals to public and private gas distributors in the Greenwood area.

Overall energy costs average $10.74 per MMBtu in Greenwood County. Electricity is the most expensive energy source at $13.03 per MMBtu and natural gas is the least expensive at $7.60 per MMBtu.

The industrial sector is by far the major consumer of energy in Greenwood County, using nearly two-thirds (62.3%) of the total energy distributed. The residential sector accounts for less than one-fourth (23.4%) and the commercial sector only 14.3%. The industrial sector pays substantially less per MMBtu for energy than the residential or commercial sectors for both electricity and natural gas.

10.3.5 Renewable and Nonrenewable Energy and Local Resources

Renewable energy sources are natural, but flow-limited, resources that can be replenished. Renewable energy resources include biomass, hydro, geothermal, solar and wind. Such resources are virtually inexhaustible in duration, but limited in the amount of energy that is available per unit of time. Some resources (such as geothermal and biomass) may be stock-limited in that stocks are depleted by use, but on a time scale of decades, or perhaps centuries, they can likely be replenished.

Nonrenewable resources are sources of energy that cannot be replenished naturally or that can take millions of years to produce. Nonrenewable energy resources include fossil fuels such as coal, oil, natural gas, and nuclear fuel (uranium).

Hydroelectricity is considered a renewable resource. The small percentage of electricity provided to Greenwood CPW by the Southeastern Power Administration is produced by federal hydroelectric generation facilities. A small percentage of the electricity provided by SCE&G also comes from hydroelectric generation facilities. The remaining energy distributed within Greenwood County is generated from nonrenewable sources such as nuclear power, coal, oil, and natural gas.

While much of the energy distributed in Greenwood County is generated within South Carolina, very little local energy is generated within the County. Most of the County's electricity is generated at the Duke Power Oconee Nuclear Station and SCE&G facilities throughout the State. However, some electricity is generated by Duke Power's Buzzard's Roost facility in Greenwood County. Natural gas and petroleum products are refined and distributed from facilities outside of South Carolina, throughout the southeast.

10.3.6 Environmental Impact of Local Energy Resources

Emissions from petroleum-based products such as carbon monoxide, nitrogen oxides, carbon dioxide (CO_2), hydrocarbons, particulates and other toxins are the major components of smog and pollution. According to EPA statistics, the 200 million cars and light duty trucks on American highways are responsible for over half of all air pollution.

Air pollution levels are cause for concern for several reasons. First, air pollution causes health problems in humans, wildlife and plantlife. The South Carolina Energy Office (SCEO) reports than an estimated $45 billion is spent annually on health problems related to poor air quality. Second, air pollution damages water supplies, introducing new toxins into water bodies. Finally, scientists have linked air pollution and high levels of carbon dioxide in the atmosphere to the "greenhouse effect" and global warming. This phenomenon occurs when carbon dioxide and other gases in the air absorb infrared radiation in the atmosphere. When this happens the atmosphere cannot release energy at the same rate it takes energy in, resulting in a slight rise in temperature. Such seemingly small temperature changes can eventually cause drastic changes in the atmosphere.

The gases that help trap the Sun's heat close to the Earth's surface are referred to as "greenhouse gases." The most important greenhouse gases include water vapor, carbon dioxide, methane, nitrous oxide, and several engineered gases. Water vapor is by far the most common, with an atmospheric concentration of nearly 1%, as compared with less than 0.04% for carbon dioxide. According to the US Energy Information Administration (EIA), atmospheric concentrations of greenhouse gasses including carbon dioxide, methane, nitrous oxide and most man-made gases have increased by about 25% since large-scale industrialization began some 150 years ago.

The consumption of energy in the form of fossil fuel combustion is the largest single contributor to greenhouse gas emissions both within the nation and worldwide. Fossil fuels consist primarily of hydrocarbons, made up of hydrogen and carbon. When burned, the carbon combines with oxygen to yield carbon dioxide. The amount of carbon dioxide produced depends on the carbon content of the fuel. For each unit of energy produced, natural gas emits about half and petroleum fuels about three quarters of the carbon dioxide produced by coal. The US EIA reports that during 2001, more than 82% of total US greenhouse gas emissions consisted of carbon dioxide from the combustion of fossil fuels such as coal, petroleum, and natural gas. Although the industrial sector is the largest energy user nationwide, the transportation sector emits nearly as much carbon dioxide because of its nearly complete dependence on petroleum fuels.

In the short term, year-to-year changes in energy consumption and carbon dioxide emissions tend to be dominated by weather, economic fluctuations, and movements in energy prices. Over longer time spans, changes in energy consumption and emissions are influenced by other factors such as population shifts, technological advances, and energy consumers' choice of fuels, appliances, and capital equipment (vehicles, aircraft, and industrial plant equipment). The energy consuming capital stock of the country – cars and trucks, airplanes, heating and cooling plants in homes and businesses, steel mills, aluminum smelters, cement plants and petroleum refineries – changes slowly from one year to the next because capital stock usually is retired only when it begins to break down or becomes obsolete.

The US EIA reports that emissions of greenhouse gases in 2001 were 1.2% less than in 2000, but were 11.9% higher than in 1990. The short-term decline can be attributed to a reduction in overall economic growth from 3.8% in 2000 to 0.3% in 2001; a 4.4% reduction in manufacturing output that lowered industrial emissions; warmer winter weather that decreased the demand for heating fuels; and a drop in electricity demand and coal-fired power generation that reduced emissions from electricity generation. National greenhouse emissions have grown an annual average of 1.0% since 1990, with the only other emission decline in 1991 when emissions fell by 0.6%. Barring significant policy changes, the Intergovernmental Panel on Climate Change (IPCC) projects a 1.2% annual increase in US carbon dioxide emissions from 1995 to 2015.

Greenwood County energy consumers rely primarily on automotive fuels, electricity and natural gas for their energy supplies. The generation and use of each of these fuel sources can have a significant impact on the environmental quality of Greenwood County and the surrounding region.

10.3.6.1 Transportation

South Carolina Energy Office data reveals that South Carolina's transportation sector contributes 44% of the State's air pollution, which includes 53% of nitrous oxides, 24% of volatile organic compounds, 32% of carbon dioxide and 70% of carbon monoxide. Estimates developed by the Rocky Mountain Institute

indicate that an average personal vehicle in the United States emits 11,400 pounds of carbon dioxide per year.

There are 41,950 registered automobiles, 15,050 trucks, 16,344 untaxed vehicles (including state and local government, higher education, public utilities and school vehicles), 22 common carriers (public transport) and 728 motorcycles in Greenwood County. Greenwood County motorists travel more than 874.8 million miles a year, consuming more than 44.7 million gallons of fuel.

Figure 10-13. Greenwood County Registered Vehicles Fuel Consumption and Mileage, 2002

Vehicle Type	Number of Vehicles	Total Fuel Consumed (gallons)*	Total Miles Traveled	CO_2 per mile**	Total CO_2 Produced (lbs)
Passenger Car	41,950	**22,904,700**	502,896,600	0.911	458,138,803
Truck	15,050	**10,053,400**	175,844,200	1.131	198,879,790
Common Carriers	22	**15,818**	262,042	0.999	261,780
Motorcycles	728	**34,944**	1,755,208	0.391	686,286
Untaxed	16,344	**11,751,336**	194,085,000	0.999	193,890,915
Total	**74,094**	**44,760,198**	**874,843,050**		**851,857,574**

**Based on Federal Highway Administration Estimates, 2000*
*** Rocky Mountain Institute Estimates, 1999*

Based on the national estimates developed by the Rocky Mountain Institute (RMI), Greenwood County motorists produce more than 851.8 million pounds, or 425,929 tons, of carbon dioxide a year. According to State averages, it can be assumed that transportation emissions account for a significant portion of the total yearly carbon dioxide emissions in the County. Through travel reduction opportunities discussed further in Chapter 4 – such as carpooling, public transit, alternative modes of travel and development of connected roadways – significant reductions in CO_2 emissions can be realized. The RMI estimates that each gallon of fuel saved diverts 20 pounds of carbon dioxide from the atmosphere.

10.3.6.2 Electricity

The United States relies heavily on fossil fuels and nuclear power to generate its electricity. Coal accounts for 89% of the emissions from the electric utility industry nationwide. While electricity generation consumes 36% of the primary energy in the US, it is responsible for 35% of carbon dioxide emissions because coal consumption is offset by the use of non-fossil sources (nuclear, hydro and renewable energy) and natural gas (US EIA).

In South Carolina, the SCEO estimates that emissions from all fossil-fueled steam-electric generating units at the State's electric utilities increased by 34% from 1993 to 1999 and by 8.7% from 1998 to 1999. In 1999, carbon dioxide from coal-fired plants accounted for 97% of emissions from fossil-fueled generating units in the State. The pollution control most often used at electric utility plants is particulate collection, which is primarily designed to remove the ash generated from coal combustion.

Fifty-eight percent (58%) of the energy distributed within Greenwood County is in the form of electricity. The majority of electricity (84%) for Greenwood County consumers is produced and distributed by Duke Power, while 16% is distributed to residents within the City of Greenwood by Greenwood CPW (purchased from SCE&G and the Southeastern Power Administration).

More than half of the electricity produced by Duke Power and 21% of the electricity produced by SCE&G is generated by nuclear energy. The Oconee Nuclear Station generates much of the electricity for the Greenwood County area. Although nuclear power generation does not produce greenhouse gases, it does have by-product wastes in the form of radioactive materials and hot water. Most nuclear waste is low-level, in the form of tools, protective clothing, cleaning materials and disposable items that have been contaminated with small amounts of radioactive dust or particles. These materials are subject to special regulations that govern their storage so that they will not come in contact with the outside environment.

The Barnwell Low-level Radioactive Waste Disposal Facility is the only state-owned facility currently available to most of the nation for disposal of commercially-generated low-level radioactive waste. After June 30, 2008, the site will only accept waste from organizations located in South Carolina, Connecticut and New Jersey.

The irradiated fuel assemblies used in nuclear power generation are highly radioactive and must be stored in specially designed pools where water cools the fuel and acts as a radiation shield, or in dry storage containers. Older and less radioactive fuel is kept in dry storage facilities, sealed in special concrete reinforced containers. While long range plans are for spent fuel to be stored deep in the earth in a geologic repository such as the proposed site in Yucca Mountain, Nevada, currently all spent fuel is stored at the nuclear plant at which it is used.

Forty-eight percent (48%) of the electricity generated by Duke Power is from coal, oil or gas combustion and 75% of SCE&G's electricity is generated by coal. Duke Power's Buzzard's Roost plant in Greenwood County generates electricity using combustion turbine (gas) units. With more than 82% of total greenhouse gas emissions nationwide consisting of carbon dioxide from the combustion of fossil fuels including coal, petroleum and natural gas, it is assumed that electricity generation through fossil fuels is one of the key contributors to greenhouse gas emissions in South Carolina (US EIA). It is important to note that for each unit of energy produced, natural gas emits about half and petroleum fuels about three quarters of the carbon dioxide produced by coal.

The small percentage of energy purchased by Greenwood CPW from the Southeastern Power Administration and a small percentage of the electricity purchased from SCE&G is generated by hydroelectric power. A renewable resource, hydroelectric power is also a clean and inexpensive source of energy. Because hydroelectric generation does not involve fuel combustion, there is little air pollution in comparison with fossil fuel plants and limited thermal pollution compared with nuclear plants. Like other energy sources, the use of water for generation has limitations, including environmental impacts caused by damming rivers and streams, which can affect local plant, fish, and animal habitats.

10.3.6.3 Natural Gas

Natural gas is the cleanest of the fossil fuels. On a Btu basis, natural gas combustion generates about half as much carbon dioxide as coal, as well as less particulate matter and very little sulfur dioxide. The combustion of natural gas does produce nitrous oxides and the production and transmission of natural gas also results in releases of methane into the atmosphere. However, natural gas is not considered a major contributor to the concentration of these gases within the atmosphere.

Natural gas use is on the rise, both within South Carolina and nationwide. According to the SCEO, end user deliveries of natural gas in the State increased by 29.8% from 1980 to 2000. Most of the increase occurred in the industrial sector, where natural gas deliveries increased by 28.7%. Natural gas sales to residential customers in the State increased by 25.2% from 1980 to 2000, while the average use per residential customer increased by 41.7%. At the national level, the EIA projects that natural gas consumption will increase from 22 trillion cubic feet in 1999 to 34 trillion cubic feet in 2020. Much of the increase in the nation's natural gas use is expected in the electricity sector, where electricity generators are projected to account for 55 percent of total US natural gas consumption by 2020. The EIA indicates that the use of natural gas is increasing for a variety of reasons including price, environmental concerns, fuel diversification and/or energy security issues, market deregulation (for both gas and electricity), and overall economic growth.

Natural gas is a major energy source in Greenwood County, providing nearly 42% of the County's energy. The commercial sector is a key consumer, with more than 47% of its energy coming from natural gas. Natural gas is widely used in the industrial and residential sectors as well, comprising 41% of industrial energy and 39% of residential energy. Given national and state trends, it is reasonable to assume that use of natural gas within all economic sectors will continue to grow in Greenwood County, replacing energy sources that are more detrimental to the environment.

10.3.6.4 Environmental Impact Summary

All energy sources for Greenwood County are imported. With the exception of transportation emissions, a relatively small amount of greenhouse gases are produced by sources within the County. In addition, much of the electricity for County consumers is generated by nuclear power, a very clean energy source in terms of greenhouse gas emissions. Natural gas, the cleanest of the clean fossil fuels, powers key electric generators that contribute to the County's energy resources. A small percentage of the County's electricity is produced by hydroelectric power – a renewable resource with minimal environmental impact. However, energy generated by transportation fuels within the County generates 425,929 tons of carbon dioxide a year. In general, with the exception of emissions related to transportation, Greenwood County is a good citizen within its region in terms of environmental impact on air quality.

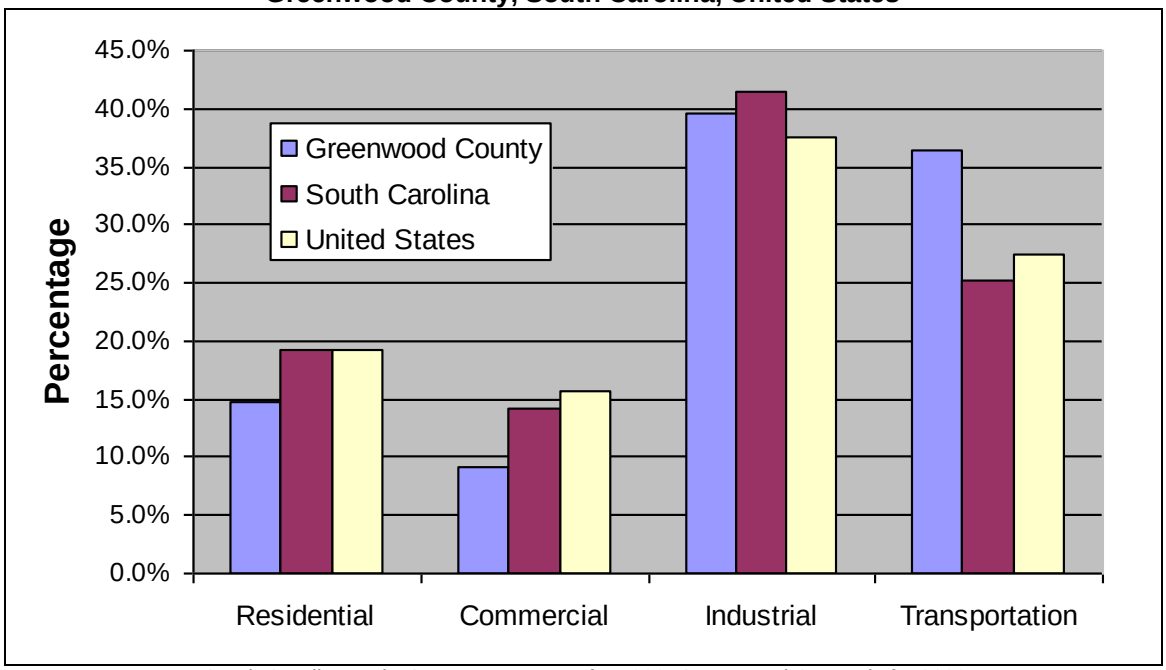
10.4 Inventory of Current Usage

A comprehensive community energy assessment builds upon the information provided through an identification and analysis of energy sources and related costs coupled with an examination of major end-use sector energy consumption. This energy analysis also includes an examination of the energy characteristics and needs that influence energy consumption within each economic sector. The South Carolina Energy Office (SCEO) divides major energy consumers into four primary categories: residential, commercial, industrial, and transportation. In addition to activities included in the SCEO economic sector definitions, the Greenwood County Energy Conservation Element also includes institutional uses such as K-12 schools, higher education, hospital, and local government uses and agricultural uses within the commercial sector.

Energy consumption within Greenwood County's economic sectors closely reflects that of the State and the nation. More than 15.3 million MMBtu of energy is distributed in Greenwood County annually. The industrial sector is the largest consumer of energy at the County, State and national level. In Greenwood County, industrial energy consumption accounts for 39.5% of energy distributed per year (more than 6 million MMBtu) – slightly lower than the State at 41.4% and a little higher than the national average of 37.5%. The share of transportation energy within the total energy picture is significantly higher in Greenwood County at 36.5% (nearly 5.6 MMBtu per year) than at the State level (25.2%) and nationally (27.5%). Greenwood County's residential sector accounts for a lower percentage of total energy use at 14.8% (nearly 2.3 million MMBtu) than statewide at 19.3% and nationally at 19.2%. The commercial sector in Greenwood County also uses proportionally less energy at 9.1% (nearly 1.4 million MMBtu) than at the State (14.1%) and national (15.7%) levels.

Greenwood County's comparatively high use of energy in the transportation sector and lower use of energy in the residential and commercial sectors is in large part due to the rural nature of the County. With nearly 44% of the population classified as rural in the 2000 Census, Greenwood County is more rural than the State (39.5% rural) and the nation (21% rural). Because rural development is generally characterized by longer travel times, more sparse residential development, and in most cases less commercial development, more energy is needed for transportation, while less energy is used in the residential and commercial sectors. No public transit options and limited private transit in Greenwood County make it critical for residents to have access to a personal vehicle, resulting in an increased number of vehicles per person. Greenwood County residents are overall financially positioned to afford personal vehicles. County residents have a per capita income and median household income that ranks 17th highest out of the State's 46 counties and is significantly higher than surrounding counties. In addition, the City of Greenwood is the center for business, healthcare, industry and government services in the six-county, Upper Savannah region. The vehicle fleets associated with these activities increase the number of vehicles per person in the County when compared with surrounding rural counties and the State as a whole.

Figure 10-14. Percentage of Energy Consumption by Economic Sector
Greenwood County, South Carolina, United States



**South Carolina and US percentages are for 1999, Greenwood County is for 2000.*
Source: 2001 South Carolina Energy Use Profile, SCEO.

Figure 10-15. Energy Distribution by Sector, 2001
Greenwood County

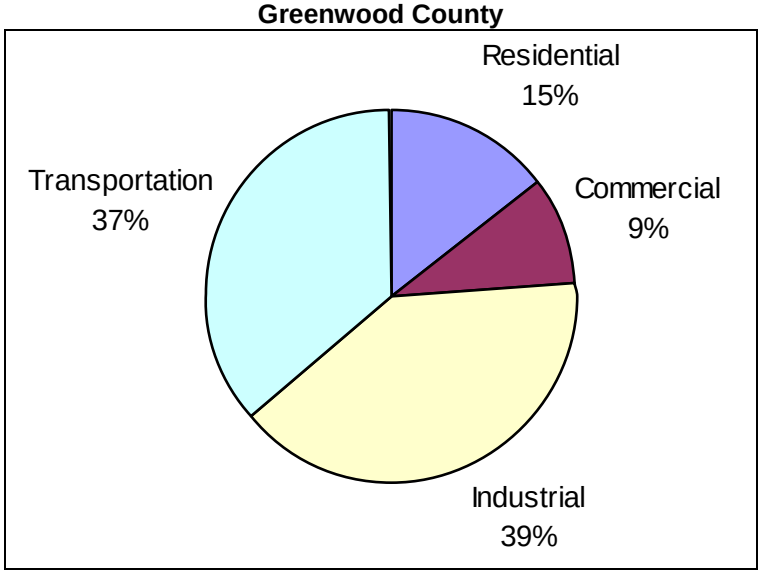


Figure 10-16. Energy Distribution and Cost by Sector, 2001
Greenwood County

Sector	Energy Distributed per Sector		Energy Cost		
	MMBtu	% MMBtu	Total	% of Total	per MMBtu
Residential	2,270,229.8	*14.8%*	$33,665,493	*21.3%*	$14.83
Commercial	1,391,714.7	*9.1%*	$18,924,294	*12.0%*	$13.60
Industrial	6,056,190.9	*39.5%*	$51,834,379	*32.9%*	$ 8.56
Transportation	5,595,024.8	*36.5%*	$53,264,636	*33.8%*	$ 9.52
Total	**15,313,446.9**	***100.0%***	**$157,685,163**	***100.0%***	**$10.30**

Greenwood County consumers spend more than $157.6 million a year for energy. The share of the total energy cost paid by each economic sector within the County is similar to the percentage of energy distributed within each sector, with a few exceptions. Although the industrial sector is the largest consumer of energy in the County, the transportation sector pays the largest percentage of energy costs at 33.8% ($53.2 million). Greenwood County's percentage of energy costs attributed to transportation is lower than that of the State (35.5%) and the nation (37.4%). The County's industrial sector expends more than $51.8 million a year for energy, nearly one-third (32.9%) of the total energy costs. This is significantly higher than the industrial sector's share of energy costs at the State (23.1%) and national (20.5%) levels. Although the residential sector accounts for only 14.8% of energy use in Greenwood County, it pays 21.3% of total energy costs with a total annual expenditure of more than $33.6 million. The residential sector share of total energy expenditures runs higher for the State at 25% and the nation at 24.6%. Similarly, the commercial sector pays for 12% of total annual energy costs ($18.9 million) in the County, although it consumes only 9.1% of the total energy distributed. In comparison, the commercial sector accounts for 15.4% of energy expenditures in South Carolina and 17.5% of expenditures nationwide.

Figure 10-17. Percentage of Total Energy Distributed and Total Cost by Sector
Greenwood County, South Carolina and the United States

Sector	Greenwood County		South Carolina		United States	
	% of Energy	% of Cost	% of Energy	% of Cost	% of Energy	% of Cost
Residential	14.8%	21.3%	19.3%	26.0%	19.2%	24.6%
Commercial	9.1%	12.0%	14.1%	15.4%	15.7%	17.5%
Industrial	39.5%	32.9%	41.4%	23.1%	37.5%	20.5%
Transportation	36.5%	33.8%	25.2%	35.5%	27.5%	37.4%

**South Carolina and US percentages are for 1999, Greenwood County is for 2001.*
Source: 2001 South Carolina Energy Use Profile, SCEO.

10.4.3.1 Residential Energy Use

The residential sector includes all private household establishments that consume energy primarily for space heating, water heating, air conditioning, lighting, refrigeration, cooking and clothes drying. To understand energy use within the residential sector, it is important to examine these demographic factors that have some bearing on energy consumption within the sector. In addition to specific energy data, it is also important to examine population and housing characteristics that can provide additional insight into energy distribution and trends.

Greenwood County's population was 66,271 in 2000, an increase of 11.3% from 1990. There were 28,243 housing units in County, with 91.1% (25,729) occupied. More than 69% of the occupied housing units in the County are owner-occupied, with 30.8% renter occupied. Single-family detached homes constitute more than 67% of the County's housing stock, with manufactured housing representing 14.2% of housing. Nearly 12% of the County's housing units are within multi-family developments with three or

more attached units. Four percent of the County's housing units are duplexes and 2.7% are attached single family units such as townhouses.

Figure 10-18. Housing Type and Units in Structure, 2000
Greenwood County

Units in Structure	Number	Percent
Total HU	**28,243**	***100.0%***
1-unit, detached	18,969	*67.2%*
1-unit, attached	763	*2.7%*
2 units	1,124	*4.0%*
3-4 units	1,265	*4.5%*
5-9 units	1,299	*4.6%*
10-19 units	289	*1.0%*
20 or more units	492	*1.7%*
Mobile Home	3,999	*14.2%*
Boat, RV, van, etc.	43	*0.2%*

Source: US Census Bureau, 2000 Census

Nearly half (46.8%) of the housing in Greenwood County was more than 30 years old in 2000. Of these older homes, 29.9% were built before 1960 and were more than 40 years old, with 9% constructed before 1939. Conversely, more than 20% of the County's housing stock is fairly new construction and less than 10 years old. More than 15% of the County's housing units were from 11 to 20 years old and 17.6% were from 21 to 30 years old in 2000.

Figure 10-19. Year Housing Unit Built, 2000
Greenwood County

Year Structure Built	Number	Percent
1999 to March 2000	771	*2.7%*
1995 - 1998	2,693	*9.5%*
1990 - 1994	2,244	*7.9%*
1980 - 1989	4,367	*15.5%*
1970 - 1979	4,968	*17.6%*
1960 - 1969	4,771	*16.9%*
1940 - 1959	5,891	*20.9%*
1939 or earlier	2,538	*9.0%*

Source: US Census Bureau, 2000 Census

According to the 2000 Census, the type of energy used to heat Greenwood County homes was almost evenly divided between electricity at 46.7% of homes and natural gas at 45% of homes. More than 12,000 homes in the County are heated by electricity and 11,587 are heated by natural gas. This is quite different than the breakdown of heating fuels used by homes statewide, where 58.4% of South Carolina homes are heated by electricity and only 26.2% by natural gas. Other heating fuels are used to a lesser extent in Greenwood County, with 899 homes heated by fuel oil or kerosene, 843 homes heated by bottled or tank LP (propane) gas, and 306 homes heated by the burning of wood.

Figure 10-20. House Heating Fuel – Occupied Housing Units, 2000
Greenwood County and South Carolina

House Heating Fuel	Greenwood County		South Carolina	
	Number	Percent	Number	Percent
Natural Gas	11,587	*45.0%*	402,555	*26.2%*
Bottled, Tank or LP Gas	843	*3.3%*	131,334	*8.6%*
Electricity	12,003	*46.7%*	895,132	*58.4%*
Fuel Oil, Kerosene, etc.	899	*3.5%*	78,331	*5.1%*
Coal or Coke	15	*0.1%*	183	*0.0%*
Wood	306	*1.2%*	19,290	*1.3%*
Solar Energy	0	*0.0%*	447	*0.0%*
Other Fuel	47	*0.2%*	2,105	*0.1%*
No Fuel Used	29	*0.1%*	4,477	*0.3%*
Total Housing Units	**25,729**		**1,533,854**	

Source: US Census Bureau, 2000 Census

More recent data obtained from Greenwood County energy providers provides a slightly different picture of the types of energy used in residences. More than 2.27 million MMBtu was distributed to residential uses in Greenwood County in 2001. Nearly 60% of this residential energy, totaling more than 1.3 million MMBtu, was provided by electricity. This is only slightly less than the 62.4% of residential energy provided by electricity at the State level. Thirty-nine percent of Greenwood County's residential energy (885,530 MMBtu) comes from natural gas – significantly higher than at the State level, where only 20.4% of residential energy is provided by natural gas. Less than one percent of the County's total residential energy is provided by either fuel oil or kerosene.

Greenwood County consumers spent more than $33.6 million annually for residential energy in 2001, at a cost of $14.82 per MMBtu. Although electricity provided 59.8% of residential energy, it comprised 68.4% ($23 million) of the total residential energy cost in the County. While natural gas customers consumed 39% of the energy in the residential sector, they paid only 31% ($10.3 million) of the total cost of residential energy. Fuel oil and kerosene customers paid less than 1% of the total cost of energy in the residential sector. Electricity customers in Greenwood County paid the most for energy at 16.95 per MMBtu. Natural gas consumers paid $11.74 per MMBtu, with kerosene cost following closely at $11.74 per MMBtu. Customers who heat their homes with fuel oil paid the least for energy at $8.65 per MMBtu.

Figure 10-21. Residential Energy by Energy Type, 2001
Greenwood County

Type	Amount Distributed		Cost		
	MMBtu	% of MMBtu	Total	% of Total	per MMBtu
Electricity	1,357,689.5	*59.8%*	$23,010,288	*68.4%*	$16.95
Natural Gas	885,530.1	*39.0%*	$10,393,296	*30.9%*	$11.74
Fuel Oil	15,852.3	*0.7%*	$137,160	*0.4%*	$8.65
Kerosene	11,157.9	*0.7%*	$114,750	*0.4%*	$10.28
Total	**2,270,229.8**	***100.0%***	**$33,655,493**	***100.0%***	**$14.82**

Source: 2001 South Carolina Energy Use Profile, SCEO.

10.4.2 Commercial Energy Use

The commercial sector includes wholesale and retail trade; finance and insurance; real estate; professional; management; administration; arts, entertainment, and recreation; accommodations and food service; repair and maintenance; and personal services. Within the Greenwood County Energy Element

institutional uses such as K-12 schools, higher education, government, and hospitals and agricultural uses are also included within the commercial sector.

According to data provided in the US Census Bureau's 2000 County Business Patterns, there were 1,062 commercial establishments in Greenwood County. Nearly 40% (348) of the commercial establishments were engaged in retail trade, 11.4% (121 establishments) in accommodations and food service, 10.6% (113 establishments) in finance and real estate, and 9.5% (101 establishments) in professional and technical services. There were 77 establishments engaged in administration, support, waste management and remediation; 66 in repair and maintenance; 55 in wholesale trade; and 55 in real estate. Personal services; transportation and warehousing; arts, entertainment and recreation; information services; and management services each included from 10 to 36 establishments and represented small percentages of total commercial establishments in the County.

Figure 10-22. Commercial Establishments in Greenwood County by Type, 2000

Type of Business	Establishments	Percentage
Wholesale Trade	55	*5.2%*
Retail Trade	348	*32.8%*
Transportation & Warehousing	29	*2.7%*
Information	24	*2.3%*
Finance & Insurance	113	*10.6%*
Real Estate	55	*5.2%*
Professional & Technical	101	*9.5%*
Management	10	*0.9%*
Administration, Support, Waste Mgmt., Remediation	77	*7.3%*
Arts/Entertainment/Recreation	27	*2.5%*
Accommodations/Food Service	121	*11.4%*
Repair/Maintenance	66	*6.2%*
Personal/Laundry Services	36	*3.4%*
Total Establishments	**1,062**	***100.0%***

Source: US Census Bureau, 2000 County Business Patterns.

Greenwood County's commercial sector consumed nearly 1.4 million MMBtu in 2001 (Table 20). More than half (51.6%) of this energy, totaling 718,435 MMBtu, was provided by electricity. Comparatively, according to the SCEO's 2001 South Carolina Energy Use Profile, electricity use in the commercial sector was significantly higher statewide at 63.9%. Natural gas accounted for 47.3% (658,787 MMBtu) of the energy used by County commercial consumers. Natural gas use in the commercial sector was substantially less at the State level, with only 22.7% of energy provided by natural gas. Fuel oil and kerosene provided only one percent each of the total energy consumed by Greenwood County's commercial sector.

Commercial energy consumers in Greenwood County spent more than $18.9 million on energy in 2001, at a cost of $13.60 per MMBtu. While electricity provided 51.6% of the energy within the commercial sector, it made up 63.5% of the total energy cost for the sector. Conversely, natural gas accounted for 47.3% of energy distributed within the commercial sector, yet represented only 35.9% of the total energy cost for commercial consumers. Both commercial fuel oil and kerosene customers paid less than 1% of the total cost of energy within the sector. Electric consumers in the commercial sector paid significantly more than other sectors for their energy at $16.72 per MMBtu. Commercial natural gas consumers paid $10.31 per MMBtu, followed closely by kerosene customers who paid $9.26 per MMBtu. Commercial consumers using fuel oil as their energy source paid the least for energy at only $7.93 per MMBtu.

Figure 6-23. Commercial Electricity by Energy Type, 2001
Greenwood County

Type	Amount Distributed		Cost		
	MMbtu	% of MMbtu	Total	% of Total	per MMbtu
Electricity	718,435.5	*51.6%*	$12,014,625	*63.5%*	$16.72
Natural Gas	658,787.0	*47.3%*	$6,794,009	*35.9%*	$10.31
Fuel Oil	13,952.2	*1.0%*	$110,660	*0.6%*	$7.93
Kerosene	540	*1.0%*	5000	*0.6%*	$9.26
Total	**1,391,714.7**	***100.0%***	**$18,924,294**	***100.0%***	**$13.60**

10.4.2.1 Energy Use in Institutional Facilities

Although institutional uses are included within the broader commercial sector they can have a significant impact on energy conservation initiatives in the community. Institutional uses including government facilities, K-12 schools and higher education offer promising opportunities for energy conservation within the realm of comprehensive planning. As high profile energy consumers, hospitals, local governments, K-12 schools, and postsecondary institutions have an opportunity to promote energy conservation through the efficient use of energy within their operations. Hospitals, local governments and educational institutions are among the leading consumers of energy within a community. This is due in part to the size of public buildings and facilities, coupled with the fact that such facilities are often older and less energy efficient. Operational requirements of institutions also significantly impact energy use. Police, fire and hospital facilities are in operation 24 hours a day, using energy around the clock. Hospitals, schools, higher education and public buildings have a great deal of traffic in and out of the buildings, significantly increasing the heating and cooling needs of such facilities.

Established in 1951 as Self Memorial Hospital, the Self Regional Medical Center (now part of the Self Regional Healthcare system) serves a population of more than a quarter of a million that includes residents of Greenwood, Abbeville, Edgefield, Laurens, McCormick, Newberry, and Saluda counties. The Self Regional Medical Center is an independent, not-for-profit hospital governed by a board of trustees comprised by community members. The 421-bed Center is one of Greenwood County's largest employers with 2,070 employees (1,684 full-time) including a medical staff of more than 170 physicians representing more than 30 specialty areas. Self Regional Healthcare system includes the Self Regional Medical Center in Greenwood, the Montgomery Center for Family Medicine in Greenwood, the Savannah Lakes Medical Center in McCormick (McCormick County), and the Ware Shoals Center for Family Medicine. The Self Regional Healthcare system's 27 buildings house patient care facilities including a women's center, heart center, neonatal intensive care, emergency care center, critical and intensive care, orthopedic, neurological and eye, ear/nose/throat, vascular unit, telemetry, behavioral health unit, outpatient surgery, operating room, pain management center, and pediatrics.

As shown in Table 21, Self Regional Medical Center is a major consumer of energy within the County, accounting for more than 13% of total energy use within Greenwood County's commercial sector in 2002. The Medical Center consumed 184,770 MMBtu of energy in 2002. More than 57% of this energy was provided by natural gas and 43% by electricity. Greenwood CPW supplies both electricity and natural gas to the Medical Center.

Figure 10-24. Self Regional Medical Center Energy Use, 2002

Electric (KWh)	Electric (MMBtu)	*% Electric*	Natural Gas (Decatherms)	Natural Gas (MMBtu)	*% Natural Gas*	Total MMBtu
23,105,784	78,860	*42.7%*	105,910	105,910	*57.3%*	**184,770**

Source: Self Regional Medical Center, 2003.

Self Regional Medical Center spent more than $1.5 million for energy in 2002. This expenditure represents nearly 8% of total energy expenditures in the County's commercial sector for 2002. The Hospital's average cost per MMBtu was $8.18, significantly lower than the average Greenwood commercial sector cost of $13.60 per MMBtu.

Figure 10-25. Annual Estimated Energy Distribution and Cost, 2002
Self Regional Medical Center

Number of Buildings	MMBtu	Cost	Average Cost per MMBtu
27	184,770	$1,511,740	**$8.18**

Source: Self Regional Medical Center, 2003.

Greenwood County, the City of Greenwood, and the Towns of Ninety Six and Ware Shoals consume more than 47,580 MMBtu per year of energy in the operation of their facilities. Government entities in Greenwood County spend $691,150 annually for energy, with an average price of $14.53 per MMBtu. Table 23 provides energy distribution and cost for Greenwood County jurisdictions.

With a total of 53 buildings, Greenwood County is the largest governmental energy consumer, using nearly 32,829 MMBtu per year at a total cost of $467,000. The average price of energy used in County facilities is $14.23 per MMBtu. The largest consumers of energy among County facilities are the Law Enforcement Center (8,333 MMBtu/year), the County Courthouse (4,861 MMBtu/year) and the five Parks and Recreation buildings (4,723 MMBtu/year). Greenwood CPW provides natural gas and electricity for the County's buildings located within the Greenwood City limits, with Duke Energy supplying electricity for the landfill and several ancillary buildings located outside of the corporate limits.

The City of Greenwood consumes 7,560 MMBtu a year in the operation of its five municipal buildings, including the City Hall, the Public Works building and two fire stations. The City spends $112,042 on energy each year, with an average cost per MMBtu of $14.82. Greenwood CPW provides electricity and natural gas for the operation of all five of the City's buildings.

The Town of Ninety Six consumes 3,020 MMBtu a year in the operation of its nine municipal buildings and provision of citywide street lighting. Ninety Six spends approximately $47,608 a year for energy, with street lighting being the largest energy expense at a cost of $24,754 annually. Street lights account for nearly half of the energy consumed by the municipality, using more than 1,491 MMBtu per year. The average cost of energy for the Town is $15.76 per MMBtu – higher than that of neighboring jurisdictions due to the Town's dependence on electricity, particular for street lighting. Duke Power provides electricity for all of the Town's facilities and street lighting. Greenwood CPW provides natural gas for the Police and Fire Station, the Library, the Depot and Town Hall.

The Town of Ware Shoals consumes nearly 4,171 MMBtu annually in the operation of its nine municipal buildings and the provision of street lighting citywide. Like Ninety Six, street lighting is both the major energy use and the greatest energy expense for Ware Shoals, representing nearly half (2,018 MMBtu) of the Town's energy usage and accounting for more than half ($33,500) of the total energy cost. The average cost of energy for Ware Shoals is $15.46 per MMBtu. Similar to Ninety Six, the average cost of energy is a little higher than neighboring jurisdictions because of the large percentage of electricity used for street lighting. Duke Power provides electricity and Greenwood CPW provides natural gas for all nine Town facilities, and Duke Power provides electricity for the Town's street lighting.

Figure 10-26. Annual Government Energy Distribution and Cost by Jurisdiction
Greenwood County Jurisdictions

Jurisdiction	Estimated Energy Distributed			
	MMBtu	Number of Buildings	Cost	Average Cost per MMBtu
Greenwood County	32,828.9	53	$467,000	$14.23
City of Greenwood	7,560.2	5	$112,042	$14.82
Town of Ninety Six	3,020.5	9	$47,608	$15.76
Town of Ware Shoals	4,170.8	7	$64,500	$15.46
Total	**47,580.4**	**74**	**$691,150**	**$14.53**

Greenwood County is served by three school districts, with a total of 24 public schools. The more than 1.5 million square feet included in the 50 buildings within the Districts house 12,252 students. Greenwood School District 50 is the largest within the County in terms of land area, number of schools and students served. District 50 has an administrative building and 16 schools including nine elementary schools, three middle schools, two high schools, an alternative school and the District's Career Center. The District accommodates approximately 9,324 Greenwood County students within its more than 1.1 million square feet of building space.

Greenwood School District 51 (Ware Shoals School District) serves students from Greenwood, Laurens and Abbeville Counties. More than half (53%) of the 1,328 students in District 51 are from Greenwood County. District 51 has 3 schools including a primary school (4K through 3rd grade), an elementary school (4th through 6th grades) and one high school for students in grades 7 through 12. The Districts three schools include 275,477 square feet of building space.

Greenwood School District 52 (Ninety Six School District) serves students residing in the eastern portion of Greenwood County. Four schools totaling 181,912 square feet of space serve 1,600 students. The District operates one primary school (4K through 2nd grade), an elementary school (3rd grade through 5th grade), a middle school (grades 6 through 8) and one high school for students in grades 9 through 12.

Greenwood County's school districts consumed more than 82,771 MMBtu in 2002. More than 63% of the district energy was provided by electricity and 37% by natural gas. District 50 was the largest energy consumer, using more than three quarters (76.4%) of the total energy distributed to the County's school districts. District 50 was also the largest consumer of electricity, using 78.5% of all electricity in this sector. Sixty-five percent of the District's total energy consumption was derived from electricity. Energy sources for Districts 51 and 52 were a little more diverse, with 43.6% and 40.9% provided by natural gas, respectively.

Figure 10-27. Energy Use in Public K-12 Schools by Type, 2002
Greenwood County

School District	Electric (Kbtu)	% Electric	Natural Gas (Kbtu)	% Natural Gas	Total Kbtu	Total MMBtu
Greenwood 50	41,127,202.9	*65.0%*	22,137,300.0	*35.0%*	63,264,502.9	63,264.5
Greenwood 51	5,795,011.2	*56.4%*	4,480,320.0	*43.6%*	10,275,331.2	10,275.3
Greenwood 52	5,457,690.8	*59.1%*	3,773,800.0	*40.9%*	9,231,490.8	9,231.5
County Total	**52,379,904.9**	***63.3%***	**30,391,420.0**	***36.7%***	**82,771,324.9**	**82,771.3**

Source: SC Energy Office, 2003.

The school districts of Greenwood County spent more than $1.2 million on energy in 2002 at an average cost of $14.99 per MMBtu. Greenwood District 50 paid nearly three fourths of that total cost – spending $920,412 for energy in 2002. District 51 spent $168,941 for energy in 2002, while District 52 spent a total of $150,248 for electricity and natural gas. Energy prices were lower for District 50 at $14.55 per MMBtu, while Districts 51 and 52 paid $16.54 and $16.28 per MMBtu, respectively.

Figure 10-28. Energy Use and Cost in Public K-12 Schools, 2002
Greenwood County

School District	Square Footage	Total MMBtu	Total Cost	Cost per MMBtu
Greenwood 50	1,117,157	63,264.5	$920,412	$14.55
Greenwood 51	275,477	10,275.3	$169,941	$16.54
Greenwood 52	181,912	9,231.5	$150,248	$16.28
County Total	**1,574,546**	**82,771.3**	**$1,240,601**	**$14.99**

Source: SC Energy Office, 2003.

Greenwood County is host to two quality institutions of higher education. Lander University (a 4-year public institution) and Piedmont Technical College (a 2-year public institution) provide a wide range of advanced educational opportunities to residents of Greenwood County and the surrounding region.

Founded in 1872 in Williamston as a private college, Lander University was relocated to Greenwood in 1904. Lander has evolved into a four-year, coeducational, state-assisted university offering majors and minors in more than 40 areas of study. Lander is situated on approximately 100 acres within the city limits of Greenwood. The campus includes 32 buildings, with a total of 878,456 square feet of building space. The University operates 7 residence halls that accommodate up to 1,086 students. In addition to six major buildings erected since 1973, campus improvements have included extensive renovations to a number of older facilities. Although the age of the University's residence halls ranges from 15 to 20 years, future plans include the construction of new housing complexes. The University's 130,000-square-foot John Drummond Complex includes the new 2,500 seat Finis Horne Arena and houses the Division of Physical Education and Exercise Studies. A $13 million Science, Mathematics and Computer Science complex was completed in 1997 and houses the Division of Mathematics and Computer Science and the Division of Biological and Physical Sciences.

Piedmont Technical College, founded in 1963 as a member of the South Carolina Technical and Comprehensive Education system, is a comprehensive 2-year post-secondary institution serving approximately 4,500 students from Abbeville, Edgefield, Greenwood, Laurens, McCormick, Newberry and Saluda Counties. The College has the largest geographic service area of the State's 16 technical colleges. The main campus of the College is the Lex D. Walters campus located within the City of Greenwood. Since Piedmont Tech serves the largest land area of all technical colleges in South Carolina, the College has built a mini-campus in each county to mitigate geographic barriers to educational attainment. In addition to the main campus in Greenwood, Piedmont operates six full-service, high-tech facilities. The Centers are equipped with both traditional and distance learning classrooms, computer labs and library resource centers and are staffed by Site Coordinators. Piedmont Tech currently operates a total of 28 buildings on its main campus and six satellite campuses, with a total of 415,083 square feet of building space.

Lander University consumed more than 70,870 MMBtu in 2002. The majority of this energy (80.3%) was provided by electricity, with natural gas accounting for 19.7% of the total energy distributed to the University (Table 26). The number of campus buildings and square footage of these facilities is a major factor in energy use. In addition, as a residential institution, Lander provides housing to more than 1,000 students – resulting in around-the-clock energy consumption. According to the SC Energy Office (SCEO), Lander University ranked 5th lowest in energy use per square foot among colleges with housing, using only 80.68 kBtu per square foot in 2002. In comparison, the average energy use per square foot for colleges with housing was 124.85 kBtu per square feet – significantly higher than energy use at Lander. The SCEO 2000 Energy Use in South Carolina's Public Facilities reported that Lander was second only to Coastal Carolina University in lowest energy usage per square feet among colleges with housing.

More than 70,870 MMBtu of energy was distributed to Piedmont Technical College in 2002. The majority of that energy (85.2%) was provided by electricity, with 14.8% provided by natural gas. As a 2-year, nonresidential institution, energy costs for Piedmont Tech are lower than for a 4-year residential institution. The College's natural gas energy use per square foot was 94.84 kBtu in 2002, significantly higher than the average for colleges without housing at only 74.2 kBtu per square foot. According to

2002 SCEO data, Piedmont Tech ranked 20th highest out of the 21 colleges without housing in terms of energy use per square foot.

Figure 10-29. Energy Use in Institutions of Higher Education by Type, 2002
Greenwood County

Institution	Electric (Kbtu)	% Electric	Natural Gas (Kbtu)	% Natural Gas	Total Kbtu	Total MMBtu
Lander University	56,894,324.3	80.3%	13,975,900.0	19.7%	70,870,224.3	70,870.2
Piedmont Technical College	33,545,035.7	85.2%	5,821,525.0	14.8%	39,366,560.7	39,366.6

Source: SC Energy Office, 2003.

Lander University paid $840,551 for energy in 2002, at a cost of $11.86 per MMBtu. The University was second only to Francis Marion University in lowest energy cost among residential institutions of higher learning in the state in 2002, spending only $0.93 per square foot. The average energy cost for all South Carolina colleges with housing was $1.21 per square foot in 2002 – significantly higher than energy costs at Lander.

The total cost of energy for Piedmont Technical College in 2002 was $464,422, with a cost per MMBtu of $11.80. According to the SCEO, Piedmont Tech ranked 8th highest among colleges without housing in terms of energy cost, spending $1.12 per square foot in 2002. The average energy cost per square foot for all colleges without housing in South Carolina was $1.21 – slightly higher than energy costs at Piedmont Tech.

Figure 10-30. Energy Use and Cost in Institutions of Higher Education, 2002
Greenwood County

Institution	Square Footage	Total MMBtu	Total Cost	Cost per MMBtu
Lander University	878,456	70,870.2	$840,551	$11.86
Piedmont Technical College	415,083	39,366.6	$464,422	$11.80

Source: SC Energy Office, 2003.

10.4.3 Industrial Energy Use

The South Carolina Energy Office includes manufacturing, construction, mining, agriculture, fishing, and forestry establishments within the industrial sector. In Greenwood County, agriculture energy use has been included in the commercial sector.

To understand industrial energy use, it is important to examine the types and sizes of industries within the County. The Census Bureau's 2000 County Business Patterns indicates that there were 94 manufacturing establishments in Greenwood County in 2000, with 31% (9,361) of Greenwood County workers employed in the manufacturing sector. The Greenwood County Economic Alliance lists 49 manufacturers with 25 or more employees. In addition, the SC Department of Commerce listed Fuji Photo Film, Inc. (1,600 employees) as the 17th largest manufacturing employer in South Carolina and Solutia, Inc. as the State's 44th largest manufacturing employer in fiscal year 2000/2001.

The 2000 County Business Patterns also indicated that nine forestry, fishing, hunting and agricultural support businesses operate within Greenwood County, along with two mining establishments and 167 construction businesses. Census information shows that 242 Greenwood County workers were employed in agriculture, forestry, fishing and hunting, and mining in 2000. More than 7% of the Greenwood County workforce (2,134 workers) were employed in construction in 2000.

Figure 10-31. Greenwood County Employers with 350 or more Employees, 2001

Manufacturer	Employees	Products
Fuji Photo Film, Inc	1,600	Photographic, medical imaging, graphic arts & recording, North American manufacturing/ R&D headquarters
Greenwood Mills	855	Textiles, corporate headquarters
Solutia, Inc.	800	Bulk continuous filament, nylon industrial yarns, polymer flake
Eaton Corporation	760	Power switchgear, bus duct/hydraulic pumps/ engineering services
Greenwood Packing Plant	700	Beef and pork products, corporate headquarters
Pfizer/Capsugel	680	Gelatin capsules, divisional headquarters
National Textiles, Inc.	547	Textiles
Park Seed Company	475	Seed & gardening supplies, corporate headquarters
VELUX American, Inc.	450	Roof windows, skylights, US corporate headquarters
Grede/Greenwood Foundaries	435	Gray and ductile iron casting
Kendall-Tyco Healthcare	400	Medical & surgical products
Goodrich Corp./Turbine Div.	385	Proprietary coating

Source: Greenwood Economic Alliance, 2001 Brochure

The industrial sector is the largest consumer of energy in Greenwood County, consuming a total of more than 6 million MMBtu in 2001 (Table 29). Nearly 59% of industrial energy in the County, totaling more than 3.5 million MMBtu, was provided by electricity. This is much higher than at the State level, where electricity provides only 27.2% of the total energy consumed in the industrial sector. More than 41% of energy distributed to the industrial sector is in the form of natural gas. Use of natural gas was much lower statewide, where it provided only 26.2% of industrial energy. Fuel oil contributed minimally to total energy usage within the industrial sector and there was no use of kerosene within the sector in 2001.

Greenwood County industrial customers spent more than $51.8 million for energy in 2001. Of all the economic sectors, the industrial sector pays the lowest energy rates, averaging $8.56 per MMBtu in 2001. Although electricity provided 58.6% of the industrial energy distributed in the County, it comprised nearly 74% ($38.2 million) of the total cost of energy within the sector. Conversely, while natural gas consumers used 41% of energy in the industrial sector, they accounted for only 26% ($13.5 million) of the total cost of energy in the sector. Fuel oil constituted a very minimal portion of the total energy costs within the industrial sector. Industrial sector consumers paid the highest rate for electricity at $10.78 per MMBtu. Rates for industrial natural gas customers were nearly half the rate for electricity at $5.41 per MMBtu. The few industrial customers using fuel oil paid $7.57 per MMBtu.

Figure 10-32. Industrial Electricity by Energy Type, 2001
Greenwood County

	Amount Distributed		Cost		
Type	MMbtu	% of MMbtu	Total	% of Total	per MMbtu
Electricity	3,550,041.2	*58.6%*	$38,257,022	*73.8%*	$10.78
Natural Gas	2,497,828.3	*41.2%*	$13,514,357	*26.1%*	$ 5.41
Fuel Oil	8,321.4	*0.1%*	$63,000	*0.1%*	$ 7.57
Kerosene	0	*0.0%*	0	*0.0%*	$ 0.00
Total	**6,056,190.9**	***100.0%***	**$51,834,379**	***100.0%***	**$ 8.56**

10.4.4 Transportation Energy Use

The transportation sector consists of all vehicles whose primary purpose is transporting people and/or goods from one physical location to another. Included are automobiles, trucks, buses and motorcycles.

Vehicles whose primary purpose is not transportation such as tractors and construction equipment are not included in this sector.

The transportation sector represents a major portion of energy consumption within Greenwood County, accounting for 37% of total energy use in 2001. This is in large part due to the nation's dependence on the automobile. The Urban Land Institute reports that between 1969 and 1990, the total number of vehicle trips taken by all Americans increased more than three times as fast as the population. This dependence is mirrored in Greenwood County, where 96% of residents travel to work by car, truck or van – 2.6% more than the State average and more than 8% higher than the national average (Table 30). Nearly 82% of Greenwood workers travel to work alone, significantly higher than the 79.4% of workers in South Carolina and 75.7% of workers nationally who drive alone. On the other hand, Greenwood residents enjoy comparatively shorter commutes to work. Mean travel time to work for Greenwood residents was 20.2 minutes in 2000, shorter than the mean for South Carolina at 24.3 minutes and the national mean travel time of 25.5 minutes. Nearly 19% of County residents drive 30 minutes or more to work one way, with only 4.7% traveling an hour or more. In comparison, a significantly higher 31.2% of residents statewide and 34.5% of workers nationwide travel more than 30 minutes to work.

Figure 10-33. Journey to Work, 2000
Greenwood County, South Carolina and the United States

Workers 16 and Older	Greenwood County	South Carolina	United States
Means of Transport to Work			
Car, Truck or Van	96.0%	93.4%	87.9%
Drove Alone	81.5%	79.4%	75.7%
Travel Time to Work			
15 - 29 minutes	41.4%	38.9%	36.1%
30 to 59 minutes	13.9%	25.3%	26.5%
60 or more minutes	4.7%	5.9%	8.0%
Mean Travel Time to Work (minutes)	20.2	24.3	25.5

Source: US Census Bureau, 2000 Census.

Automobiles and light trucks are responsible for a large portion of the total energy used within the transportation sector because they are very energy intensive. Cars and trucks consume more energy per mile than all other modes of ground transportation. Local bus systems and vanpools use less than one-third the energy of automobiles and less than one-fifth of the energy of light trucks. Additional energy savings can be realized per person when the mode of travel is capable of transporting larger numbers of people (buses), or even when an automobile or light truck transports more than one person per trip.

Figure 10-33. Transportation Intensity by Mode

Transportation Mode	Average Energy Intensity (Btu per mile traveled)
Bicycle	140
Pedestrian	400
Van Pool	600
Bus - Intercity	1,000
Motorcycle	2,300
Bus - Transit	3,400
Automobile	3,600
Light Truck	5,000

Source: Peter Miller and John Moffet, "The Price of Mobility: Uncovering the Hidden Costs of Transportation."

Information provided by the Greenwood County Auditor indicates that there are 74,094 licensed vehicles in the County. Of these vehicles, 41,950 are passenger cars, 15,050 are trucks, 728 are motorcycles, 22 are common carriers (vehicles that provide commercial transport such as taxis), and 16,344 are designated as "untaxed." This high number of vehicles carrying the "untaxed" designation includes the fleets of state and local governments, police and fire, school buses, higher education, public utilities, and other organizations that are exempt from vehicle taxes. Some individual Greenwood County residents with disabilities who meet specific eligibility requirements are not taxed as well.

Fuel consumption for each vehicle type can be estimated using vehicular fuel consumption data developed by the Federal Highway Administration. Vehicles registered in Greenwood County consumed more than 5.5 million MMBtu of energy in 2002. Passenger cars were the largest energy consumers of the various vehicles types, accounting for more than half of the energy used within the transportation sector (2.8 million MMBtu). Untaxed vehicles (including government fleet cars and school buses) consumed 26.3% (1.4 million MMBtu) of energy used within the County's transportation sector and trucks accounted for 22.5% (1.2 million MMBtu) of transportation energy use.

Figure 10-34. Vehicular Energy Consumption, 2002
Greenwood County

Vehicle Type	Number of Vehicles	Average Fuel Consumption (gallons)	Total Fuel Consumed (gallons)	Total MMBtu	% MMBtu
Passenger Car	41,950	546	**22,904,700**	2,863,087.5	*51.2%*
Truck	15,050	668	**10,053,400**	1,256,675.0	*22.5%*
Common Carriers	22	719	**15,818**	1,977.3	*0.0%*
Motorcycles	728	48	**34,944**	4,368.0	*0.1%*
Untaxed	16,344	719	**11,751,336**	1,468,917.0	*26.3%*
Total	**74,094**		**44,760,198**	**5,595,024.8**	

Sources: Greenwood County Auditor, 2002; Federal Highway Administration, 2000.

Fluctuations in petroleum prices in late 2002 and early 2003 make estimation of the cost of transportation fuel somewhat difficult. Information provided by the Federal Highway Administration can be used to estimate average fuel consumption by vehicle type. However, the average price per gallon for transportation fuels began a steady rise in late 2002 that continued into the first months of 2003. South Carolina gasoline prices in February of 2003 averaged more than 50 cents per gallon higher than a year earlier. Since it is not expected that fuel prices will go down within the next few years in an appreciable way, use of 2002 fuel price averages would be much too low to use in a credible estimate of the total cost of transportation fuel. Instead, to ensure a more realistic estimate the average price per gallon for gasoline in the nearby Columbia region in February of 2003 ($1.49 per gallon) was used to estimate total transportation costs for Greenwood County.

The estimated total annual energy cost for Greenwood County's transportation sector was more than $66 million in early 2003. Fuel for passenger cars accounted for nearly 54% to the total energy cost for the sector, with an annual cost of more than $34 million. Energy costs for trucks and untaxed vehicles were more than $14 million each, with each accounting for approximately 23% of total energy cost within the transportation sector.

Figure 10-35. Estimated Vehicular Energy Cost, 2003
Greenwood County

Vehicle Type	Number of Vehicles	Average Fuel Consumption (gallons)	Total Fuel Consumed (gallons)	Average Price per Gallon, Columbia Region 2/03*	Annual Transportation Fuel Bill
Passenger Car	41,950	546	**22,904,700**	$1.49	$34,128,003
Truck	15,050	668	**10,053,400**	$1.49	$14,979,566
Common Carriers	22	719	**15,818**	$1.49	$23,569
Motorcycles	728	48	**34,944**	$1.49	$52,067
Untaxed	16,344	719	**11,751,336**	$1.49	$17,509,491
Total	**74,094**		**44,760,198**	**$1.49**	**$66,692,695**

Sources: Greenwood County Auditor, 2002; Federal Highway Administration, 2000; SouthCarolinaGasPrices.com

Of all the economic sectors, the greatest opportunity to significantly reduce energy consumption within the Greenwood region lies within the transportation sector. State, regional and local governments have wide-ranging legal and financial powers to influence transportation. They directly supply or regulate the supply of most transportation infrastructure including roadways, sidewalks, transit, bike paths and parking. If improvements and additions to transportation systems are designed with energy conservation in mind, significant energy savings can be realized.

10.4.4.1 Energy Use in Transportation Fleets

Although included within the transportation sector, transportation fleets are an important component of local energy use and as such merit closer examination. Both the City of Greenwood and Greenwood County operate sizable vehicle fleets that include a variety of on-road vehicles. There are a total of 191 on-road vehicles in the County fleet. Nearly 43% of the County-owned vehicles are passenger cars, 34% are heavy trucks and more than 17% are light trucks including sport utility vehicles. The City's transportation fleet totals 106 vehicles. More than 41% of the City-owned fleet is comprised of passenger cars and 43% are light trucks.

Figure 10-36. Fleet Inventory – On-road Vehicles, 2002
Greenwood County and City of Greenwood

Vehicle Type	Greenwood County	City of Greenwood
Passenger Car	82	43
Light Truck	33	46
Heavy Truck	65	9
Ambulance	9	8
Fire Truck	--	--
Total	**191**	**106**

Source: City of Greenwood and Greenwood County, 2003.

Greenwood County spent more than $149,845 to fuel its on-road vehicles in 2002, using more than 120,589 gallons of gasoline and 72,154 gallons of diesel fuel. The County obtains a contracted purchase price for its fuel, resulting in significant savings. Contracted prices for the County in 2002 were $0.74 for gasoline and $0.84 for diesel fuel – significantly lower than average fuel prices. County vehicles consumed more than 25,080 MMBtu of energy in 2002, with more than 60% of that energy provided by gasoline.

Expenditures for the City's transportation fleet fuel were more than $110,377 in 2002. The City's on-road vehicles consumed more than 64,227 gallons of gasoline and nearly 43,581 gallons of diesel fuel during that year, at an average price of $1.04 per gallon for gasoline and $1.00 for diesel fuel. The City's on-

road fleet consumed nearly 14,073 MMBtu of energy in 2002, with gasoline producing 57% of that energy.

Figure 10-37. Fleet Energy Use and Expenditure, 2002
Greenwood County and the City of Greenwood

City of Greenwood				
Fuel Type	**$/Gallon**	**Gallons**	**Price**	**MMBtu**
Gasoline	$1.04	64,227.3	$66,796.39	8,028.4
Diesel Fuel	$1.00	43,580.9	$43,580.90	6,044.2
Total		**107,808.2**	**$110,377.29**	**14,072.6**
Greenwood County				
Gasoline	$0.74	120,589.3	$89,236.08	15,073.7
Diesel Fuel	$0.84	72,154.0	$60,609.36	10,007.0
Total		**192,743.3**	**$149,845.44**	**25,080.7**

Source: City of Greenwood and Greenwood County, 2003.

Fleet management practices represent one of the greatest opportunities for local governments to reduce energy consumption within their operations. Many of these procedures are relatively simple and inexpensive to implement. When it is time to replace older vehicles, the purchase of fuel efficient models will substantially reduce fuel consumption over time. Carefully matching tasks with the appropriate vehicle can ensure that more fuel-efficient vehicles are used whenever possible. Regular maintenance, including proper tire inflation, will keep vehicles operating efficiently, while integration of optimal operational procedures will reduce unnecessary stops and other gas intensive driving habits.

10.5 Projected Future Energy Needs

When conducting a comprehensive community energy assessment it is important to develop an understanding of the community's future energy needs. An analysis of future energy needs provides the critical data needed to build an effective plan for energy conservation that will be viable for decades to come.

Because the most reliable and readily available projections of future growth are population projections, energy need projections are generally based on per capita energy use. In South Carolina, the Division of Research and Statistics of the State Budget and Control Board provides population projections by county based on the most recent Census data. Greenwood County's population is projected to grow by 7.4% from 2000 to 2010. This growth rate is lower than the projected statewide growth rate of 10.8% during the same period. From 2010 to 2020, the population of Greenwood County is expected to increase by an additional 4.4% - less than half the rate of growth projected statewide.

Figure 10-38. Population Projections, 2000 to 2020
Greenwood County and South Carolina

	2000	% Growth 2000-2010	2010	% Growth 2010-2020	2020
Greenwood County	66,271	*7.4%*	71,170	*4.4%*	74,290
South Carolina	4,012,012	*10.8%*	4,446,240	*9.1%*	4,849,980

Source: SC State Budget & Control Board, Division of Research and Statistics

In its 2003 Annual Energy Outlook, the US Energy Information Administration predicts that demand for energy services will increase markedly in the coming years. The average home of the future is expected to be 6.6% larger and a more intensive user of electricity by 2025. Personal highway travel is expected to average a 1.4% growth rate per year between 2001 and 2025. With the growth in demand for energy services, primary use per capita in the United States is projected to increase by only 0.07% per year

through 2025, with efficiency improvements in many end-use energy applications making it possible to provide higher levels of service without significant increases in total energy use per capita.

10.5.1 Electricity and Natural Gas

Per capita energy use in the non-transportation sector of Greenwood County's energy consumers was 146.6 MMBtu in 2000. Electricity and natural gas are the primary sources of energy in this sector locally and at the State and national levels, providing 99.5% of all energy used in the residential, commercial and industrial sectors. Per capita electricity use for Greenwood consumers was 84.9 MMBtu and per capita natural gas consumption was 61 MMBtu in 2000.

Figure 10-39. Greenwood County Energy Consumption Per Capita, 2000 (MMBtu)

2000 Population	Total Energy use	Per Capita Energy Use	Electricity Use	Per Capita Electricity Use	Natural Gas Use	Per Capita Natural Gas Use
66,271	9,718,135.4	146.6	5,626,166.2	84.9	4,042,145.4	61.0

Source: 2000 Population - US Census Bureau, 2000 Census.

In developing energy projections on a per capita basis, it stands to reason that if the population of the community is increasing, increasing amounts of electricity and natural gas will be needed to support the growing population. However, this methodology does not address a few key factors that are difficult to quantify:

- New uses of electricity that would significantly alter per capita consumption such as electric vehicles;
- New businesses and industries that may use large quantities of energy but do not represent an increase in population;
- Energy efficiency improvements in buildings, equipment and appliances; and
- Effective energy conservation programs.

Total energy use for Greenwood County is projected to grow by 7.4% from 2000 to 2010 – rising by more than 718,401 MMBtu. From 2000 to 2020, energy consumption is expected to rise by more than 1.1 million MMBtu – a growth of more than 12%. The County's total energy consumption by 2010 is projected to be more than 10.4 million MMBtu, rising to nearly 11 million by 2020.

Consumption of energy generated by electricity in Greenwood County is expected to grow by more than 415,907 MMBtu in the first decade of the century and by 680,784 MMBtu by 2020. Natural gas consumption is projected to increase by nearly 298,811 MMBtu in 2010 and by more than 489,112 MMBtu by 2020.

To maintain or decrease the current level of energy use as the population of the County grows, the per capita energy use would have to decrease by approximately 2 MMBtu (580 kWh) a year. Though this may seem like a small amount, it is significant in relation to the average energy use for a single-family home in the Greenwood area at 22,188 kWh per year. By comparison, the energy needed to provide lighting for the average home is 1,114 kWh (US Department of Energy and the US Environmental Protection Agency's *Home Energy Saver* website). While it may be difficult to maintain or decrease per capita energy use, it is extremely important to minimize rising energy consumption within all economic sectors. Although emerging technologies may offer some relief to rising energy use, the most significant energy savings can be realized through policies and programs that promote and integrate energy conservation into the daily life of community residents.

Figure 10-40. Projected Energy Consumption Per Capita, 2000 - 2020
Greenwood County (MMBtu)

Year	Population	Per Capita Energy Use	Total Energy Use	Per Capita Electricity Use	Total Electricity Use	Per Capita Natural Gas Use	Total Natural Gas Use
2000	66,271	146.6	9,718,135.4	84.9	5,626,166.2	61.0	4,042,145.4
2005	66,610	146.6	9,767,847.2	84.9	5,654,946.1	61.0	4,062,822.4
2010	71,170	146.6	10,436,536.3	84.9	6,042,073.4	61.0	4,340,955.9
2015	71,640	146.6	10,505,458.2	84.9	6,081,974.7	61.0	4,369,623.2
2020	74,290	146.6	10,894,060.4	84.9	6,306,950.1	61.0	4,531,257.7

Source: Population Projections - SC State Budget & Control Board, Division of Research and Statistics.

Using total energy cost data and 2000 census population data, it is estimated that Greenwood consumers paid more than $1,575 per capita for energy in 2000. Per capita cost for electricity was $1,105.75, with the cost of natural gas at $463.27 per person.

Figure 10-41. Greenwood County Energy Cost per Capita, 2000

2000 Population	Total Energy Cost	Per Capita Energy Cost	Electricity Cost	Per Capita Electricity Cost	Natural Gas Cost	Per Capita Natural Gas Cost
66,271	$104,414,167	$1,575.56	$73,281,935	$1,105.79	$30,701,662	$463.27

Source: 2000 Population - US Census Bureau, 2000 Census.

As demand for energy increases, so does the total cost of energy. However, several additional factors are key in the projection of energy prices including unit price changes and availability of supplies. Trends such as energy supply disruptions and international political actions or conflicts can affect energy supplies and prices in the short-term. Long-term projections are based on fundamental issues including the availability of energy resources, emerging technologies, developments in the US electricity market and the impact of economic growth on projected energy demand. These factors are difficult to quantify at the local level and were not included in the Greenwood County projections.

The total cost of energy for Greenwood County is projected to grow by 7.4% from 2000 to 2010 – increasing by more than $7.7 million during that time period. From 2000 to 2020, the cost of energy is expected to increase by more than $12.6 million – representing growth of more than 12%. The total energy cost for the County is projected to surpass $112 million by 2010, and exceed $117 million by 2020.

The cost of energy generated by electricity in Greenwood County is expected to increase by more than $5.4 million from 2000 to 2010 and by $8.8 million by 2020. Natural gas costs are projected to increase by nearly $2.3 million by 2010 and by more than $3.7 million by 2020.

Figure 10-42. Projected Energy Cost per Capita, 2000 - 2020
Greenwood County

Year	Population	Per Capita Energy Cost	Total Energy Cost	Per Capita Electricity Cost	Total Electricity Cost	Per Capita Natural Gas Cost	Total Natural Gas Cost
2000	66,271	$1,575.56	$104,414,167	$1,105.79	$73,281,935	$463.27	$30,701,662
2005	66,610	$1,575.56	$104,948,283	$1,105.79	$73,656,798	$463.27	$30,858,712
2010	71,170	$1,575.56	$112,132,852	$1,105.79	$78,699,210	$463.27	$32,971,244
2015	71,640	$1,575.56	$112,873,367	$1,105.79	$79,218,932	$463.27	$33,188,983
2020	74,290	$1,575.56	$117,048,610	$1,105.79	$82,149,280	$463.27	$34,416,660

Source: Population Projections - SC State Budget & Control Board, Division of Research and Statistics.

The US Energy Information Administration's 2003 Annual Energy Outlook notes that average electricity prices are projected to decline from 2001 to 2007 as a result of cost reductions in an increasingly competitive market where excess generating capacity has resulted from the recent boom in construction and the continued decline in coal prices. Electricity restructuring is expected to contribute to declining projected prices through reductions in operating and maintenance costs, administrative costs and other miscellaneous costs. After 2008, average real electricity prices are projected to increase by 0.4% per year as a result of rising natural gas prices and a growing need for new generating capacity to meet electricity demand growth.

US EIA projections also show an increase in natural gas prices after 2002 as technology improvements prove inadequate to offset the impacts of resource depletion and increased demand. Natural gas prices are projected to increase in an uneven fashion as higher prices allow the introduction of major new, large volume natural gas projects that temporarily depress prices when initially brought on-line.

10.5.2 Transportation Fuels

With more than 74,000 registered motor vehicles in Greenwood County, the transportation sector represents a significant portion of total energy use, consuming 37% of total energy per year (5.5 million MMBtu). Vehicles within the County consume more than 44.7 million gallons of fuel annually. More than half of the energy consumed within Greenwood County's transportation sector is used by passenger cars. Per capita energy use for the County's transportation sector was 84.4 MMBtu in 2000.

Figure 10-43. Greenwood County Transportation Energy Consumption per Capita, 2000 (MMBtu)

2000 Population	Total Energy use	Per Capita Energy Use
66,271	5,595,024.8	84.4

Source: 2000 Population - US Census Bureau, 2000 Census.

In the development of projections for per capita energy use in the transportation sector, there are several variables that can significantly affect fuel consumption, but are very difficult to quantify at the local level. These factors include:

- Increased vehicular fuel efficiency;
- Changes in the average number of vehicles per person;
- New technologies that rely on alternative energy sources such as electricity, ethanol, methanol, and natural gas; and
- Effective energy conservation programs.

Long-term projections included in the US EIA's 2003 Annual Energy Outlook indicate that alternative fuels will displace 1.5% of light duty vehicle fuel consumption by 2025 in response to current environmental and energy legislation intended to reduce oil use. However, gasoline's share of demand is expected to

be sustained due to relatively low gasoline prices and slower fuel efficiency gains for conventional light duty vehicles (cars, vans, pickup trucks and sport utility vehicles). Energy prices directly affect the level of oil use through travel costs and average vehicle fuel efficiency. Most of the price sensitivity is seen as variations in motor gasoline use in light-duty vehicles, because the stock of light-duty vehicles turns over more rapidly than the stock for other modes of travel. In the case of high oil prices, gasoline use is projected to increase by 1.8% per year, while low oil prices could result in a higher projected increase in gasoline use of 2.1% per year.

Fuel efficiency is projected to improve at a slower rate through 2025 than it did in the 1980s, with fuel efficiency standards for light-duty vehicles assumed to stay at current levels. Projected relatively low fuel prices and higher personal income are also expected to increase the demand for larger, more powerful vehicles. Average horsepower for new cars in 2025 is projected to be 27% above the 2001 average, but advanced technologies and materials are expected to keep new vehicle fuel economy from declining. Advanced technologies such as variable valve timing and direct fuel injection, as well as electric hybrids for both gasoline and diesel engines, are projected to boost the average fuel economy of new light-duty vehicles by approximately 2 miles per gallon, to 26.1 miles per gallon in 2025.

Fuel economy in new automobiles is projected to reach approximately 30.1 miles per gallon by 2025, as a result of advances in fuel-saving technologies. Three of the most promising, each of which would provide more than 8% higher fuel economy, are advanced drag reduction, variable valve timing and lift, and extension of four valve per cylinder technology to six-cylinder engines. Advanced drag reduction reduces air resistance over the vehicle, while variable valve timing optimizes the timing of air intake into the cylinder with the spark ignition during combustion. Increasing the number of valves on the cylinder improves efficiency through more complete combustion of fuel in the engine.

Advanced technology vehicles, representing automotive technologies that use alternative fuels or require advanced engine technology, are projected to reach 21% of annual projected light-duty vehicle sales by 2025. Hybrid electric vehicles, introduced into the U.S. market in 2000, are anticipated to sell well, at 1.7 million units by 2025 – leading advanced technology vehicle sales. Projections for alcohol flexible-fueled vehicles follow with approximately 1.2 million vehicle sales by 2025. Sales of turbo direct injection diesel vehicles are projected to increase to 750,000 units by 2025. These advanced technologies will initially sell for less than $7,000 above an equivalent gasoline vehicle, but only the gasoline hybrid and the turbo direct injection diesel can achieve vehicle ranges that exceed 500 miles while delivering 20 to 35% better fuel economy than a comparable gasoline vehicle.

As the population of a jurisdiction increases over time more vehicles and vehicle trips will be needed, resulting in a growth in per capita consumption of transportation fuels. Energy use within Greenwood County's transportation sector is projected to grow by 7.4% from 2000 to 2010, increasing by more than 413,605 MMBtu during the first decade of the century. From 2000 to 2020 energy consumption in the transportation sector is expected to rise by more than 677,015 MMBtu – a growth of more than 12%. Total energy consumption for the County's transportation sector is projected to reach more than 6 million MMBtu by 2010 and nearly 6.3 million MMBtu by 2020.

Figure 10-44. Projected Transportation Energy Consumption Per Capita, 2000 – 2020
Greenwood County, (MMBtu)

Year	Population	Per Capita Energy Use	Total Energy Use
2000	66,271	84.4	5,595,024.8
2005	66,610	84.4	5,623,645.4
2010	71,170	84.4	6,008,629.9
2015	71,640	84.4	6,048,310.4
2020	74,290	84.4	6,272,040.4

Source: Population Projections - SC State Budget & Control Board, Division of Research and Statistics.

Calculations using total transportation energy costs and Census 2000 population figures indicate that Greenwood County residents spent more than $63.6 million for transportation fuels in 2000. Per capita cost for transportation energy in the County was $959.77.

Figure 10-45. Greenwood County Transportation Energy Cost Per Capita, 2000

2000 Population	Total Energy Cost	Per Capita Energy Cost
66,271	$63,604,808	$959.77

Source: 2000 Population - US Census Bureau, 2000 Census.

Similar to other energy fuels, as demand for energy increases, so does the total cost of transportation fuels. However, additional global factors may also affect transportation fuel prices. In the short-term, transportation fuel prices have begun a steady rise in response to higher crude oil prices in late 2002 and early 2003. This increase is expected to continue for the foreseeable future. Gasoline prices in February of 2003 averaged more than 50 cents higher per gallon than the previous year. Reasons for the recent rise in price include unrest in resource rich Middle Eastern countries, strikes by Venezuelan petroleum workers, and a recovering economy here in the United States. As with other energy sources, transportation fuel supply and price is affected in the long-term by fundamental variables including the availability of energy resources and improvements in technology.

The cost of transportation fuels in Greenwood County is expected to increase by 7.4% from 2000 to 2010 – a rise of more than $4.7 million during that decade. From 2000 to 2020 the cost of transportation energy is projected to increase by nearly $7.7 million – a growth of more than 12%. The total cost of transportation energy is expected to be more than $68.3 million by 2010, rising to more than $71.3 million by 2020.

Figure 10-46. Projected Transportation Energy Cost Per Capita, 2000 - 2020
Greenwood County

Year	Population	Per Capita Energy Cost	Total Energy Cost
2000	66,271	$959.77	$63,604,808
2005	66,610	$959.77	$63,930,169
2010	71,170	$959.77	$68,306,713
2015	71,640	$959.77	$68,757,804
2020	74,290	$959.77	$71,301,190

Source: Population Projections - SC State Budget & Control Board, Division of Research and Statistics.

Crude oil prices are determined largely by the international market and production in both Organization of Petroleum Exporting Countries (OPEC) and non-OPEC nations. Since gasoline is refined from crude oil, gasoline prices are closely related to those for crude oil. The EIA projects that oil prices will rise in the long-term, due in large part to higher world oil demand. Growth in oil production in both OPEC and non-OPEC nations is expected to lead to relatively slow growth in prices through 2025, although EIA analysts point out that this forecast assumes sufficient capital will be available to expand production capacity.

Greenwood County, the City of Greenwood, and the Towns of Ninety Six and Ware Shoals can play a key role in the facilitation and implementation of energy conservation efforts in the community in the following areas:

- **Leadership**. Local governments build and maintain infrastructure; purchase, manage and sell land; set standards, regulations, taxes and fees; procure large amounts of products and services; and provide key services such as water, waste management and transportation. By making energy conservation a visible priority in all of their policies and procedures, local governments are well-positioned to lead by example.

- **Regulation**. Local governments can review and revise zoning and land development regulations, building codes and other requirements that hinder energy conservation and sustainable development.

- **Coalition Building**. Local governments can convene development stakeholders to discuss and identify common ground on the issues of energy conservation and sustainable development. Because solutions to these issues rarely follow jurisdictional boundaries, local governments can also seek partnerships in both the public and private sectors that promote regional solutions and savings.

Working together, the members of the Energy Planning Advisory Committee (EPAC), Planning staff, the Planning Commission, and County and City Councils can foster support and encourage the adoption of energy conservation practices throughout the community. To assist in the implementation of energy conservation measures, Appendix C provides sample programs and funding sources for local energy conservation.

10.6 Opportunities for Energy Conservation and Sustainability

Opportunities for promoting energy conservation and sustainability throughout Greenwood County, along with programs available to assist in implementation, are explored in the sections that follow. These opportunities are presented within a diverse planning context that includes natural resource conservation, economic development, housing, community facilities, transportation, and land use.

It is important to note that such opportunities can not attain substantial energy savings if implemented in isolation. They must be included as a part of a comprehensive strategy that provides a breadth of energy conservation measures. Long-term success relies on the County working in cooperation with neighboring jurisdictions to establish regional approaches to energy conservation.

Many of these opportunities for energy conservation and sustainability will also help to further the objectives of the seven basic elements of the Greenwood City/County Comprehensive Plan. Good planning, whether for energy conservation and sustainability or for the attainment of other community goals, speaks to a range of issues and will result in an improved quality of life for Greenwood residents.

10.6.1 Environmental Opportunities

While there are many ways to conserve energy, some of the most effective measures incorporate resources found in nature. Natural resources such as sunlight, wind, vegetation and water can address energy needs and reduce the demand for non-renewable energy sources. Landscaping, recycling, and the preservation of land for open space are just a few practical ways in which environmentally-based approaches can be used to save energy, conserve resources and improve environmental quality.

10.6.1.1 Urban Forestry and Landscaping

Land use and development density can have an adverse impact on both the local and global environments. The more densely an area is developed, the higher the temperatures are likely to be. On warm summer days with calm winds, city air can be 2 to 12 degrees Fahrenheit (E F) hotter than the surrounding countryside. Dark roofs and paving materials absorb more of the sun's radiation than vegetation, causing both surface temperature and overall ambient temperature in urban areas to rise. This phenomenon, called the *urban heat island effect*, has intensified throughout the past century.

The urban heat island effect significantly affects energy usage in cities. The American Planning Association (APA) in the article "Urban Trees, Air Quality, and Energy Conservation" reported that for every 1E Fahrenheit increase in summer temperatures, peak cooling loads increase by 1.5 to 2%. The air conditioning needed to compensate for the urban heat island effect comprises 3% to 8% of urban electricity use, costing Americans an additional $1 billion annually.

Trees have been identified as a "low tech," cost-effective tool for energy conservation and can save energy by:

- Reducing the need for air conditioning through shade;

- Breaking the force of winter winds and lowering heat costs;
- Serving as a renewable source of fuel;
- Reducing air temperatures through evapotranspiration;
- Sequestering, or "locking up," carbon – an element that is a key factor in atmospheric pollution and the threat of global warming;
- Decreasing lawn space with trees and reducing areas that require the use of power mowers.

Urban forests have been shown to lower the ambient temperature of a city's summer "heat islands" if local tree canopies are sufficiently mature. Planting trees along streets reduces the heat absorbed by asphalt and can reduce the energy used for cooling in adjacent buildings. Evening ambient air temperatures in neighborhoods with well-shaded streets are up to 10E F cooler than areas with less shading. The inclusion of trees in parking areas can also partially block the suns rays onto parked cars, reducing temperatures both within the cars and in the fuel tanks. While cooler vehicle interiors require less initial air conditioning, cooler gas tanks result in less fuel evaporation and therefore less hydrocarbon emissions. The use of trees and other vegetation to reduce surface temperatures not only saves energy, it can also improve air quality and make urban environments more livable. According to the California Energy Commission, a healthy urban tree can also absorb 10 to 50 pounds of carbon dioxide (CO_2) per year, making the urban forest a valuable tool in controlling air pollution.

American Forests, an organization devoted to promoting a sustainable future for the nation's urban and rural forests, has developed the *CITYgreen* computer program to help local governments, community groups, citizens and developers quantify the benefits of trees. *CITYgreen* is a Geographic Information System (GIS) software program, offered to communities by American Forests, for mapping urban ecosystems and measuring the economic and environmental benefits of trees, soils and other natural resources. The program enables users to analyze impacts of storm water runoff, summer energy savings, carbon storage, air quality and urban wildlife. Local governments can use *CITYgreen* to estimate the effectiveness of tree ordinances, model design standards for subdivisions, and determine potential energy savings derived from additional shade. The program is an application written for use with ArcView, an Environmental Systems Research Institute (ESRI) GIS product.

The Greenwood City/County Planning Department and the Upper Savannah Land Trust received a *2002 South Carolina Forestry Grant* to inventory urban trees within the City limits. The Greenwood City/County Planning Department also applied in 2002 for funds to develop a Citywide *Urban Forestry Management Plan*. This Plan will be used for the systematic management, protection, conservation and maintenance of community trees on public properties. Strategies were included to develop streetscapes and identify areas that are needed to increase the urban tree canopy within the City limits.

10.6.1.2 Open Space

Open spaces provide opportunities for preserving existing vegetation and introducing additional trees into an area. Open spaces are unimproved parcels or areas of land or water that are set aside, dedicated, designated, or reserved for resource protection and public or private use as active or passive recreation areas. While many jurisdictions require the inclusion of open space in new developments, some communities have developed comprehensive greenway systems that link open spaces – in some cases providing miles of uninterrupted greenways within urban or suburban areas. Greenways link a number of outdoor opportunities in a continuous corridor. A greenway can be a simple path surrounded by just enough natural vegetation to mask the sights and sounds of the city, or it can include linkages to larger open spaces such as a spacious park, wildlife refuge, or historic site.

Open spaces and greenways are popular primarily because of the visual beauty and recreational benefits they offer. The significant energy savings and improved air quality these spaces provide are less tangible benefits, often unheralded by advocates. As noted earlier, the trees and vegetation that are an important feature of open spaces and greenways help cool air temperatures in hot weather by providing shade and

evapotranspiration and block cold winds in winter months, thereby reducing energy needs for heating and cooling. When greenways are used for travel on foot or by bicycle to primary destinations such as work or school, they can also help reduce vehicle trips.

The recent *Greenwood City/County Zoning Ordinance* revision provides incentives for developers to include parks, open spaces, sidewalks and bicycle paths within new developments. Developers will be allowed an increase in density of up to 35% when these amenities are included in the development. Pedestrian and bicycle paths are also encouraged as alternative modes of travel, thus reducing vehicle trips, while parks and open spaces are promoted to provide greater opportunities for preserving existing vegetation and introducing additional trees into the area.

10.6.1.3 Alternative Fuels

The use of nonrenewable energy sources dominates national and local energy consumption. However, continued reliance on and increasing levels of consumption of these traditional sources – coal, oil, and natural gas – poses a future challenge as these natural resources are finite in supply and can be exhausted over time. Nuclear energy, a major energy source in South Carolina, is also a concern – generating toxic waste by-products and costly, long-term storage requirements.

Efforts to reduce our national dependence on these exhaustible natural field sources and the potentially hazardous affects of nuclear energy are yielding viable fuel alternatives. These alternative fuels represent renewable energy sources that can be adapted to various communities based on regional and local geographic, climactic, and geological constraints.

The most widespread and promising of these alternative fuel sources for South Carolina communities such as Greenwood are solar, biofuel, and geothermal energy. Although the technology to capture and convert solar energy is now readily available, the cost-effectiveness of the technology at smaller scales remains the primary limiting factor for application at the local level. Biofuel potential is being realized through the Greenwood County landfill and the utilization of the landfill's methane gas as an energy source for County facilities, and for potential sale to local residences, businesses, or industry. Greenwood County will continue to explore opportunities to harness such naturally occurring energy and convert it into a usable product. Harnessing heat from beneath the Earth's surface, geothermal energy utilizes water and geothermal wells to warm and cool facilities. Geothermal heat pumps are among the most efficient and comfortable heating and cooling technologies available – and particularly suited for the State's moderate climate.

10.6.1.4 Recycling

Although most of us recognize that recycling is driven by environmental concerns, it can also yield significant energy savings. Less energy is used to produce products from recycled material than from virgin material. For example, producing aluminum cans from recycled materials uses 90% less energy than manufacturing cans from new materials. Savings for other metals range from about 50% to 90%. Producing recycled paper uses from 23% to 70% less energy, depending on the grade of paper.

Figure 10-47. Energy Savings from the Recycling of Selected Waste Materials

Material	Million Btu per Ton Saved	Percent Energy Saved
Aluminum	168.5- 281.0	92 - 96%
Steel	7.8 - 19.0	47 - 74%
Steel and Iron	9.2 - 15.5	63 - 74%
Lead	5.5 - 17.4	56 - 65%
Copper	40.3 - 94.7	84 - 95%
Glass (20% recycled)	0.59	4%
Glass (50% recycled)	1.47	11%
Glass (100% recycled)	2.95	22%
Plastic – polyethylene	96.0	97%
Plastic – polymer	--	90 - 95%
Rubber	22.0 - 22.1	70 - 71%
Newspaper (33% recycled)	1.23	23%
Newspaper (100% recycled)	2.42	53%
Paper	14.0 - 35.5	60 - 70%
Low grade paper	12.0	70%
High grade paper	--	60%
Writing & printing paper	16.4	33%
Corrugated cardboard	6.3 - 12.2	24%
Paperboard	--	10 - 20%

Source: Energy Aware Planning Guide, California Energy Commission

The Greenwood County Recycling Program (GAPPS) program is one of South Carolina's first curbside recycling programs, currently serving more than 18,000 households throughout Greenwood County. GAPPS (Glass, Aluminum, Paper, Plastic and Steel) represents the materials collected on the curbside routes. Recyclables are delivered to the Material Recovery Facility (MRF) located at the landfill complex where they are separated and processed by inmate laborers for sale to recycling vendors. The County also operates nine Solid Waste and Recycling Convenience Centers to serve residents who do not have curbside collection. Greenwood County's GAPPS program continues to grow, with the County's recycling rates increasing each year. Recycling has had a notable impact on the life of the County's Sub-title D landfill (the first approved site in South Carolina). Over the ten year period since the inception of the recycling program (1993-2003) the MRF processed more than 24,000 tons of recyclable material. Without recycling, this material would have been land filled at the rate of $35 per ton and would have greatly decreased the life of the landfill. Recycling efforts to date have saved the equivalent of one cell of landfill space, extending the life expectancy of the County landfill by an estimated 8 to 10 years.

10.6.1.5 Ambient Air Quality

The Environmental Protection Agency (EPA) and the South Carolina Department of Health and Environmental Control (SC DHEC) regulate and protect air quality within the State. Most of South Carolina, including Greenwood County, is below the threshold for ambient air quality standards. However, increased urbanization in the surrounding Greenville, Augusta, and Columbia metropolitan areas will have future impacts on local air quality in the Greenwood area.

Air quality affects public health, the weather, the quality of life, and the economic potential of a community. Air quality can be influenced by short-term, temporary events such as wildfires, or by more serious, long-term conditions such as ozone and haze. The federal *Clean Air Act* establishes federal standards for six primary air pollutants – ozone, lead, dust, carbon monoxide, nitrogen dioxide and sulfur dioxide.

One of the main concerns with air quality in South Carolina is ozone. Although ozone plays a key role in protecting the earth from solar radiation, problems can arise when it occurs in concentrated areas closer to ground level creating health risks for residents such as asthma, damaging vegetation, and escalating deterioration of outdoor structures. Ground-level ozone (O_3) forms when oxides of nitrogen and volatile

organic compounds are heated by the sun during the spring and summer months. Ground-level ozone is a natural occurring effect that humans can exacerbate. Increases in population, automobile and fossil fuel-based engine usage, and development (especially industrial development) within the last five years have resulted in increased ozone levels in South Carolina. In December of 2002, Greenwood County entered into an Early Action Compact with 45 of the 46 counties in the State to develop a statewide early action plan to reduce ozone. This statewide agreement encourages county participation in local ozone reduction initiatives. This proactive approach reduces ozone before levels reach critical thresholds where the Environmental Protection Agency (EPA) would mandate county implementation of ozone reduction measures. Greenwood County should analyze these factors in relation to the growing ozone problem and develop local solutions that manage ozone within acceptable levels that work in-hand with the promotion of development.

Between 2000 and 2002, Greenwood County was below the 8-hour ozone standard established by DHEC. The minor air quality problems found in Greenwood County can be attributed to industrial uses, automobile emissions and open burning practices. In a 1997 citizen opinion survey conducted by the City/County Planning Department, 73.47% of residents polled rated the air quality of Greenwood County as good or excellent.

Population and traffic are the two key contributors to air quality problems. There are currently 74,094 registered vehicles in Greenwood County, along with 1,200 road miles. Therefore, land use decisions weigh heavily on long-term air quality conditions. Compact development should be encouraged and the impact on transportation and the number and length of vehicle trips generated should be considered when siting new community facilities. Accommodations for alternative forms of transit should also be made to provide accessible and safe pedestrian and biking routes.

10.6.2 Economic Development

The County's economic health influences virtually every aspect of life for residents – from jobs and taxes to education and quality of life. Emerging from an agrarian tradition, Greenwood County has successfully launched the transformation of its economy into a diversified base of manufacturing, trade, services, education, and health care. By integrating economic development processes with other local planning considerations such as sustainability and energy conservation, the myriad of fiscal and environmental uncertainties and concerns posed by growth can be diminished.

A community's economic development strategy has clear implications for land use, transportation, energy conservation and other local planning issues. Although some degree of economic development can, and likely will, happen by default in any community, only a carefully planned program will advance the type of growth and quality of life desired by residents. Such a comprehensive approach lays the foundation for quality economic development that is balanced with local environmental concerns, renewable and reliable energy sources, cost-effective infrastructure utilization, and sound community fiscal capacity.

Energy efficiency influences all aspects of the local economy and any balanced discussion of energy use and attempts at energy conservation must include the economic sector, especially industrial and commercial interests. The industrial sector is a primary user of energy in Greenwood County, consuming more than a third (39%) of energy distributed annually within all economic sectors. Together, the commercial and industrial sectors consume nearly half (48%) of the energy distributed in Greenwood County each year.

Both direct and indirect impacts of energy investments affect a community's economic health. Direct costs are easily quantifiable as revealed in actual energy expenditures by individual businesses and industries in the form of utility bill payments, equipment purchases and new construction. The indirect investments in energy efficiency, however, are even more far-reaching, stimulating multiple spin-off benefits in the form of additional jobs, services and equipment purchases.

10.6.2.1 Business and Industry Recruitment and Retention

The local economic development strategies of the past two decades have succeeded in guiding the County's successful transition to a manufacturing and service-based economy. Given the success of

these efforts, future economic growth offers an opportunity to refine these development strategies as a primary vehicle to incorporate the concepts of sustainability and energy conservation.
For a growing number of cities and counties throughout South Carolina, the economic development strategies that have proven effective in the past are now at a crucial crossroads. Communities are now looking beyond an influx of new jobs in search of a sustainable economic growth strategy that addresses other local concerns such as brownfield redevelopment, education and training, job and wage security, cultural resources enhancement, traffic congestion, pollution prevention, natural resources conservation and infrastructure development.

In light of this shifting emphasis from quantity to quality in economic development, many localities are realizing new economic growth opportunities by encouraging businesses in energy efficiency, materials recycling, environmental technologies and brownfield redevelopment. An increasing number of local governments are developing specific sustainable economic development strategies that focus on advancing their community's long-range development vision. These sustainable strategies often include one or more of the following: the development of eco-industrial parks; the encouragement of infill development and revitalization of downtowns; the facilitation of waste recycling and renewable energy use among business and industry; the efficient design and operation of industrial and commercial facilities and production processes; the development of financial incentives for sustainable practices; and the adoption of regulatory streamlining and reform measures by local governments.

10.6.2.2 Revitalization and Infill

Sensible growth initiatives encourage the development of land closer to existing urban development, provide incentives for infill and the redevelopment of previously developed areas, and avoid encroachment of new development into areas that lack the necessary public facilities, services and infrastructure. This strategy facilitates the revitalization of urban centers and contributes to the retention of existing infrastructure investments. The revitalization of existing built properties and the infill of new development on vacant lands within developed areas also produces significant energy conservation benefits. Commercial and employment centers sited in developed areas offer more convenient access to retail stores, governmental services, health care, cultural venues and other amenities – reducing the need for lengthy commutes and encouraging the use of public and alternative transportation.

Localities can use economic development as an effective tool for achieving the revitalization and infill of developed areas. Industrial, retail and service sector development that contributes to the long-term health of central business districts and other underdeveloped or declining areas should be encouraged. Capital improvement programs for redevelopment districts can be designed that not only foster infill projects, but also encourage restoration and reuse of properties and buildings of historical significance. Such efforts can be augmented by the location of jobs near existing workforce housing, the development of shared parking facilities and alternative transportation systems, and the linkage of job sites with convenient, affordable transit service.
Jurisdictions can delineate special districts to assist in achieving economic development and land use goals and develop marketing plans and targeted economic incentives to encourage private investment in designated redevelopment areas. The redevelopment of existing facilities and build-out of vacant properties within developed areas alleviates growth pressures on community infrastructure. For areas beyond the central business district, planners and local officials can evaluate and pursue appropriate commercial and/or industrial projects within master planned communities. This mixed-use strategy encourages compact development and creates employment opportunities within close proximity to housing, again facilitating alternative transportation and reducing reliance on cars.

The Town of Ware Shoals is working to make the Riegal Textile Mill site an important part of their community once again. The Reigal Mill was the Town's largest employer until it closed in 1985. The site is located on the shoals of the Saluda River, in the center of Town. A revitalization plan is underway to revitalize the area as an infill and mixed-use development that once again will serve as the center of the community.

10.6.2.3 Industrial Ecology

Industrial park development is a tried-and-true tool for economic development. By providing a designated focal point for manufacturing and other related facilities, such parks inherently contribute to the efficient

distribution of energy resources. Water and sewer, natural gas, telecommunications, and electrical transmission lines, along with railways and roads, can be extended to serve a centralized cluster of industries in a single park instead of scattered individual sites.

Common utilities and infrastructure access is typically the only thing shared by park occupants of older industrial parks. However, the traditional industrial park concept is evolving to encompass a more holistic view in which companies are part of a shared industrial ecosystem. This new breed of industrial park is promoted as an approach to reduce waste, improve efficiency, reduce environmental impacts and, ultimately, boost a company's bottom line. Such parks emphasize a bond between manufacturers as part of a common industrial ecosystem for business and environmental excellence with an integrated and sometimes shared network, or ecology, of suppliers, customers, geography and markets.

Eco-industrial development, also known as green industry, offers a practical strategy to implementing sustainable economic development. According to the Center of Excellence for Sustainable Development of the US Department of Energy, the concept centers on the production of economically valuable goods and services while reducing the ecological impacts of production. Seven basic criteria for eco-efficient industrial operations have been outlined by the World Business Council for Sustainable Development:

- Reduction of the material intensity of goods and services
- Reduction of the energy intensity of goods and services
- Reduction of toxic dispersion
- Enhancement of material recyclability
- Maximization of sustainable use of resources
- Reduction of material durability
- Enhanced service intensity of goods and services

The location of eco-industrial operations within a mixed-use development offers an energy-efficient, environmentally-sensitive employment option that contributes to a diverse but compatible economic mix.

10.6.2.4 Renewable Energy and Recycling

The development and use of locally renewable energy resources, particularly by the industrial sector, is requisite to curbing the adverse economic and environmental effects of the State's current energy use and consumption patterns. Both businesses and local governments are now recognizing the benefits of capturing the economic and energy-generating potential of waste streams. Many counties, municipalities and regions across the nation are actively assessing the potential of their local waste streams and recruiting employers who can not only create much needed jobs, but can also incorporate what would normally be considered unwanted waste and pollutant by-products into viable components of their production processes and end products.

The sharing of what the originating source considers a waste product with a business or industry who can utilize that byproduct in a productive way not only benefits both parties, it also keeps those materials from ending up in the local landfill. Industrial byproducts that are used in the production of other products minimized public costs for additional landfill space or costly technology to clean the waster for release into the environment. In addition, facilitating the location of these compatible industries within close proximity of one another minimizes the cost and the energy used in transporting the material. In the late 1980s, Greenwood County studied the use of steam generation from landfill material as a means to recycle unwanted materials, generate energy and lower costs to industries located within the County industrial park. Similar alternatives should be reviewed as technological advances make such generation measures more affordable and lessen the overall impacts to the environment.

The creation of local and regional recycling and resource recovery programs, with an emphasis on resource recycling supports job creation in both the public and private sectors. For example, the US Department of Energy reports that biomass energy production supports nearly 70,000 jobs nationwide and, given present growth trends, biomass power could provide more than 280,000 jobs within the next

decade. A 1995 study by the North Carolina Office of Waste Reduction documented more than 8,000 private sector and 1,000 public sector jobs attributed to recycling activity in North Carolina.

10.6.2.5 Financial Incentives, Education, and Technological Advances

Although not as clearly within the parameters of local planning, local governments can influence energy efficiency in the areas of industrial and commercial facility construction and site design, facilities management, production processes, and the development and application of new technologies in the workplace. Community concern over industrial and commercial energy savings is warranted, because each dollar that is saved on energy bills can instead be reinvested into the business and thus, the local economy.

Research has shown that investment in energy efficiency measures yields greater local economic benefits than mere energy bill expenditures. The economic contrast between utility costs and efficiency investments can be quantified by the use of economic multipliers to define energy investments in terms of dollar impact. For instance, the economic multiplier for payment of an electric bill is only $1.75, compared to a multiplier of $2.32 generated by purchasing energy efficiency measures. In short, the energy efficiency option translates into an additional local economic benefit of $0.57 more per $1.00 spent than with the traditional utility bill expenditure. Although actual economic multipliers differ among regions, energy efficiency investments will outpace traditional utility bill expenditures in overall economic impact. The typical utility bill payment will exit the local economy, leaving minimal lingering impact. Investments in energy conservation measures can leverage community economic growth – when local construction firms are used for facility modification and equipment installation and upgrades; when new, energy-efficient equipment is purchased from local vendors; and when energy savings increase a company's productivity and profitability, resulting in business expansion and the addition of new jobs for local residents.

Working in partnership with local employers, communities can mobilize technical assistance, financial incentives, and new technologies to enhance the energy efficiency and in effect, the economic competitiveness, of business and industry. Specific activities by local governments that can encourage efficiency investments by businesses include:

- Establishing partnerships with local utilities and industries to develop energy efficiency and conservation programs that generate cost savings for local businesses;
- Making energy conservation information available through the business licensing and building permit processes;
- Sponsoring workshops on energy conservation practices;
- Conducting energy audits for commercial and industrial facilities;
- Partnering with employers and utility providers to construct demonstration facilities where energy-efficient design principles are put into practice and showcased;
- Assisting local employers with applications for grant and loan programs that help cover the costs of retrofits and the development and implementation of new technologies in the work environment; and
- Facilitating local and regional eco-industrial recycling partnerships for waste by-product incorporation into industrial production processes and energy generation.

10.6.2.6 Regulations and Incentives

Regulation of land use, design, construction and environmental practices is considered integral to ensuring community safety and quality of life. However, cumbersome and prolonged review processes and antiquated regulations can impede the recruitment and cultivation of energy-friendly businesses. Local governments and designated economic development authorities can take the following regulatory and policy steps to stimulate energy-efficient and environmentally sound economic development:

- Conduct surveys and compile a database of existing industrial waste streams and potential users to serve as a basis for focused economic marketing and recruitment;

- Streamline regulations and approval processes, allowing flexibility to accommodate new manufacturing technologies, emerging markets for recycled goods, and the innovative re-use of waste by-products in production processes;

- Pursue federal and state funding opportunities for public and private sector led pilot energy efficiency projects and the development and testing of new conservation technologies and products;

- Involve local business and industry representatives on local energy advisory committees and in the energy conservation planning process;

- Facilitate and foster partnerships among existing and potential industries for waste stream recycling and by-product re-use;

- Work with State officials to identify and secure tax breaks, loans, financing, infrastructure grants and other incentives and work to eliminate existing financial disincentives for desirable industries; and

- Minimize the uncertainties faced by the private sector by clearly linking economic development decisions with the land use planning, zoning, permitting, codes enforcement and inspections functions.

Local governments must undertake economic development decisions within the overall context of other planning functions, including planning, zoning, permit approvals, inspections, housing development, community revitalization, capital improvements and transportation. The community's support for economic development must be reflected in a decision-making process that is clear and consistent. By integrating economic development decisions with their other responsibilities, South Carolina communities can reduce the regulatory and procedural barriers that often impede the realization of sustainable development objectives.

10.6.3 Housing Opportunities

Nearly 15% of the energy consumed in Greenwood County is attributed to residential use. South Carolina has experienced a 97% increase in residential energy use since 1970, more than twice the national increase. As residential energy consumption continues to rise, its impact on overall energy consumption becomes more significant. Consequently, in order to substantially reduce overall energy use at the local level it is important to include policies and programs that target reductions in residential energy use.

With nearly half of residential energy consumption in the State devoted to indoor temperature control, energy conservation efforts must include measures designed to reduce heating and cooling needs. Since heating and cooling are closely tied to factors such as outside air temperature and wind, it is possible to implement residential construction and development design measures that will result in significant energy savings. Greenwood County is within a humid subtropical region, characterized by hot, humid summers and mild winters. The average annual temperature is 60.8EF, with the average high temperature reaching 73EF and the average low dipping to 48EF. The warmest temperatures are typically recorded in July, while the coldest temperatures are usually in January. The average heating degree days for the Greenwood area are 3,239 and the average cooling degree days are 1,501.

Development design characteristics such as density and housing type are significant factors in residential energy use. Multi-family and other attached housing unit types incorporating shared walls require less energy for heating and cooling. Smaller detached single-family, attached single-family and multi-family homes use less energy for space heating and cooling than larger, more traditional single-family detached homes.

Proper siting of individual housing units can also yield energy savings, with the site orientation of a building having a significant effect on heating and cooling needs. In hot, humid Southern states such as South Carolina, protecting homes from the hot summer sun and assuring good air movement in and through the site are important design considerations. If possible, homes in South Carolina should be oriented to face south or southeast. However, building orientation in residential developments is often dependent on the street layout, since houses generally face the street. If street orientation is primarily from east to west, either the front or back walls of the homes (the largest sides with the most windows) should face south.

Exterior shading is critical, since it is seven times more effective to cool a building by shading the exterior rather than by interior shading such as blinds or draperies. Trees are one of the most effective ways to keep the sun's rays from entering a building. Through proper placement of a few mature trees, a building can be shaded for most of the daytime hours.

Building construction and materials also play an important role in energy consumption. The Greenwood City/County Building Department adopted and began enforcement of an energy code in 1992. In keeping with State regulations, both the City and the County replaced the 1992 energy code in 2002 with the *2000 International Energy Conservation Code* (IECC). The energy code requires new dwellings to have insulation with a minimum rating of R-30 for ceilings, R-13 for exterior walls, R-19 for floors (with crawl space) and R-6 for ductwork in unconditioned spaces. Double-pane windows or single-pane with storm windows are also required.

According to Census 2000 figures, approximately 85% of the housing stock in Greenwood County was built prior to 1992 and therefore was not required to meet energy code standards. Since adoption of the energy code in 1992, all new dwellings constructed in the County have been required to meet these standards. With an estimated 1,071 new homes constructed in the County since April of 2002, the percentage of dwellings that were not required to meet the energy code has dropped to 82%. As older homes drop out of the housing market and are replaced by new homes, the percentage of the County's housing stock that does not conform to energy code standards will continue to decrease.

Manufactured housing comprised 14.2% of all housing in Greenwood County in 2000. Historically, manufactured housing has not been considered an energy-efficient housing choice. However, in an effort to promote energy-efficient construction in manufactured housing, the SC Energy Office launched an energy efficiency certification program in 1998. Through this program, the SCEO distributes SC Manufactured Housing Energy Efficiency Labels to qualified manufacturers. This label certifies that the manufactured home meets or exceeds the energy efficiency levels provided for in the *South Carolina Code of Laws*. By law, energy labels may only be placed on homes that meet or exceed the minimum requirements for energy efficiency. To meet energy efficiency standards, the home must have storm or double-pane glass windows, insulated or storm doors, and a minimum insulation thermal resistance rating of R-11 for walls, R-19 for floors and R-30 for ceilings, or equivalent allowances. The impact of the program on overall energy efficiency in the manufactured housing sector has been substantial, with an average of 65% of manufactured homes sold in the State from 1998 to 2001 certified as energy-efficient – a major increase from the 4% of manufactured homes sold in 1992 that met energy efficiency standards.

Figure 10-48. Estimated Percentage of New Manufactured Homes in South Carolina with Energy Efficiency Labels

Year	Manufactured homes	Energy Labels Distributed	Percentage With Labels
1998	19,969	10,555	52.9%
1999	15,835	11,727	74.1%
2000	9,631	5,860	60.8%
2001	6,859	5,595	81.6%
Total	**52,294**	**33,737**	**64.5%**

Source: Manufactured Housing Institute of South Carolina, March 2003.

10.6.4 Community Facilities

Community facilities include projects and activities essential to a community's sustained growth and development. Utilities, infrastructure, governmental and educational functions are addressed under the vast community facilities umbrella. These functions include water and sewer service, electric and natural gas, telecommunications access, stormwater management, transportation, solid waste collection and disposal, police and fire protection, health care, emergency medical services, governmental facilities, emergency preparedness, educational facilities, parks and recreation, libraries and other institutional uses through siting, construction and operation. Community facilities have substantial influence on energy usage patterns in a community and provide an effective arena for the introduction and implementation of energy conservation measures.

While community facilities and public institutions are provided and maintained primarily by local governments within the community, some facilities such as roads and educational centers are built and maintained by state or federal governments. Institutional facilities also include hospitals, health clinics, private schools and colleges and other public, non-governmental facilities.

Local governments and institutions are among the leading consumers of energy within a community. This is due in large part to the size of public buildings and facilities, coupled with the fact that such facilities are often older and less energy-efficient. Institutions such as hospitals, police stations and prisons are in operation 24 hours a day and rely on equipment that requires substantial amounts of energy around the clock. Schools and other public buildings have a great deal of traffic in and out of buildings, which significantly increases the heating and cooling needs of such facilities.

As high-profile energy consumers, local governments and service providers have a unique opportunity and responsibility to promote energy conservation through the efficient use of energy within their operations. Local government conservation efforts typically fall into one of six categories: administration, policies and employee education; community facility site selection; building efficiency and site design; facility management; and fleet efficiency.

10.6.4.1 Administration, Policies and Education

Energy costs represent top budget expenditure categories for most local governments. Faced with tightening fiscal conditions and growing public demand for efficiency and accountability, local governments and public institutions nationwide have begun to incorporate energy conservation measures into their policies and procedures.

Local governments and institutions can realize significant energy savings by revising policies and operational procedures to make energy conservation a high priority. Through the adoption of policies such as office recycling, local governments and institutions can save energy, reduce costs, and serve as examples to the community. Efforts can range from the recycling of common office waste such as paper and plastic to the production of energy from landfill gases. The following recommendations are common steps for local governments or institutions in developing and implementing an effective energy conservation program.

- Designate a lead office for the energy planning effort.
- Conduct an energy assessment.
- Identify major institutional goals and issues related to energy conservation.
- Build support from all departments and coordinate activities.
- Identify and analyze energy plan options.
- Write and adopt an energy-efficiency plan.
- Establish a fund for upfront costs for energy efficiency improvements.

- Implement the energy-efficiency plan.

- Monitor progress, evaluate programs and update strategies.

10.6.4.2 Site Location

Facilities planning for governmental and institutional uses should incorporate sound energy conservation principles not only in building design, but in site selection processes as well. Because of the physical nature of community facilities, such planning has substantial influence on the type and direction of growth as well as the potential for redevelopment of an area. Locating new buildings or facilities near transit, bicycle and pedestrian facilities will encourage the use of alternative modes of travel. Close proximity of facilities to other related uses, along with adequate pathways, will decrease vehicular travel between facilities. For example, location of the county fueling station(s) near vehicle intensive departments such as public works or the sheriff's department can reduce travel. Also, many local governments and institutions are major employment centers. When they are located near essential services such as retail, restaurants, childcare and other necessary destinations, employees are more likely to use alternative modes of transportation.

Governmental and quasi-governmental organizations – federal, state, regional and local – can have considerable influence on a community's long-term energy efficiency through site selection decisions for public facilities. The location of federal post offices, federal and state courthouses, state health and social services offices, regional transportation centers and routes, federal and state corrections facilities, post-secondary institutions, and other essential facilities can either complement or derail community development plans.

Perhaps the most significant, but often overlooked, example of the importance of site selection is the location of new schools. Recommendations on improving the site selection and design process at the local level to facilitate energy conservation include:

- Include local jurisdiction planners in meetings with school facility planners and developers to ensure compliance with local comprehensive plans;

- Initiate formal review and comment process for local jurisdictions on proposed school sites and designs;

- Ensure coordination between local planners and school district officials on school site design and linkages to existing transportation networks to encourage walking and biking opportunities; and

- Prepare transportation cost-benefit analyses of proposed school sites to strengthen decision-making process.

When carried out in coordination with the community land use plan, school siting can strengthen local development and energy conservation goals. Schools built within close proximity of existing residential areas encourage alternative modes of travel such as biking or walking and require shorter vehicular trips. When schools are located near essential commercial services such as dry cleaners, day care centers, and health providers such as dentists and doctors, fewer trip miles are needed to reach multiple destinations.

10.6.4.3 Site Design and Building Efficiency

The potential for energy savings in local government and institutional facilities is significant. Energy savings equate to dollar savings as well. The money saved through energy conservation measures can be redirected to meet the pressing fiscal requirements of other administrative, operational, programmatic and facilities infrastructure needs.

Site design and building orientation influence energy use. When possible, new construction and additions should be oriented to take advantage of solar heating in the winter, while maximizing prevailing breezes to reduce air temperatures in warm-weather months. Landscaping should be incorporated to provide

shading and reduce ambient air temperatures in the summer. During colder months, landscaping can also divert winter winds by acting as wind breaks.

Energy savings can also be realized through either retrofitting existing facilities with energy-efficient technologies and designs or by encouraging energy-efficient design and the use of energy-efficient technologies in new buildings. It is important to include energy savings as a factor when considering return-on-investment for either retrofits or new construction. Determining potential energy savings for the retrofit of existing buildings requires a comprehensive energy audit.

Several notable efforts have been implemented or are underway at the local level. *Piedmont Technical College* has participated in several energy conservation assistance programs administered by the SC Energy Office, with projected savings of more than $126,980 in energy expenditures within ten years of the completion of each project. Project activities included retrofits of major campus facilities, with projects completed in 1994, 1996 and 1997. As a requirement of participation in SCEO energy conservation programs, Piedmont Tech is also a partner in the *Rebuild South Carolina* program. The SCEO provides a walk-through energy use audit for *Rebuild South Carolina* partners to assess the energy costs and efficiency of facilities by analyzing energy bills and conducting a brief survey of the structure. Assistance in the development of an energy conservation plan is also provided, along with advice on funding options and monitoring of energy savings realized through conservation initiatives.

Greenwood School District 51 is currently participating in the SCEO *Schools Lighting Grant Initiative*. Under this program, energy efficient lighting will be installed and illumination levels brought into compliance with the *SC School Facilities Planning and Construction Guide* at Ware Shoals High School.

Greenwood County has made a number of changes and improvements to County facilities over the last few years to promote energy savings and conservation. For instance, HVAC upgrades have resulted in significant energy savings for County facilities. The replacement of a 1966 vintage boiler and air conditioning system in the Courthouse has resulted in reductions of almost 40% in energy usage and annual utility expenses. These savings were realized despite the addition of more than 50 computers to the building. The savings were achieved by dividing the existing ductwork into zones and replacing the large whole-building AC units with separate gas heat and AC units for each zone. Economizers were installed on most of the new units to further aid in energy reductions by using outside air to meet cooling needs when the temperatures are appropriate. At the Park Plaza facility, new HVAC units have been installed that utilize gas heat and air conditioning to replace the existing air conditioners with electric duct zone heat. Units were divided by floor to eliminate multi-zone cooling by using individual zone reheat operations, resulting in a 20% reduction in energy use. Existing electric duct heaters in the Civic Center formerly on a central control were replaced by gas duct heaters with four zone controls, resulting in a more evenly dispersed heating system with less overheating in any zone due to spectator body heat when only one or two sections are used. Lighting upgrades have also resulted in reduced energy consumption in County buildings. The main courtroom in the Courthouse has undergone a relighting project using metal halide fixtures in an indirect lighting scheme that has reduced the lighting load while improving ambient light levels in the courtroom. Older mercury vapor lighting systems in the Sports Complex have been replaced with high efficiency metal halide fixtures to improve lighting levels and reduce electrical consumption.

10.6.4.4 Facilities Management

Energy use by community facilities varies widely and is dependent on factors such as the number and age of buildings and facilities, climate, and types of activities conducted. Although it is difficult to develop an overall picture of energy use by local government and institutional facilities such as hospitals, energy consumption and cost data is available for school districts, state agencies and public institutions of higher education in South Carolina. The South Carolina Energy Office (SCEO) compiles this energy data on an annual basis, focusing exclusively on energy use by buildings and fixed facilities. Transportation-related energy use and costs are not included in the annual report. In addition to the categorical profiles outlined in the SCEO report, each institution, district and agency receives a customized report from the Office that details energy costs and usage per square foot and provides comparisons to the facility averages in each category. The data also enables the SCEO to identify institutions and individual structures with unusually

high energy usage and/or expenditures. This data can then be referenced against the detailed, building-by-building data provided by each institution to locate specific problems.

An assessment of energy usage is an essential tool in the effort to reduce energy use. Periodic energy use assessments of equipment, systems and maintenance practices will uncover inefficiencies and provide the data necessary to recommend and evaluate needed upgrades and retrofits. These assessments should include larger systems and facilities such as water and wastewater facilities, HVAC and computer systems, and road maintenance and landfill equipment. Energy use by smaller systems such as lighting systems for individual buildings and landscaping equipment should also be addressed.

Routine maintenance of most mechanical and electronic equipment can save energy. Staff should be trained in proper maintenance techniques and methods, with on-going updates on new technologies and procedures. To encourage staff participation and interest, rewards or recognition can be used to acknowledge employees who go the extra mile in conserving energy. A standard methodology for tracking energy use and comparing actual performance with conservation goals should be developed early on to both inform and motivate employees.

10.6.4.5 Fleet Efficiency

Many local governments and institutions operate and maintain a fleet of vehicles. Although these fleets vary greatly in size and composition, they present a prime opportunity to institute energy saving measures. Local governments and institutions can save significant amounts of energy and money by increasing the fuel efficiency of individual vehicles, operating vehicles more efficiently, and improving overall fleet management practices.

There are numerous opportunities for local governments and institutions to make fleet operations more energy efficient. Some ideas for implementation include:

- Implement a management information system to closely track maintenance schedules, fuel consumption, mileage, fuel costs and other related information.
- Assign vehicles appropriate to the task.
- Purchase fuel-efficient and appropriately-sized vehicles.
- Practice preventative maintenance such as keeping tires properly inflated.
- Train maintenance staff in practices that improve fuel economy.
- Train drivers in fuel-efficient driving techniques.
- Centralize fleet operations to achieve an economy of scale, improve maintenance efficiency, and more effectively implement fuel efficiency programs.
- Automate fueling stations to track fuel efficiency, schedule preventative maintenance, and discourage excessive personal use of fleet vehicles.
- Explore use of alternative fuel vehicles.

10.6.5 Transportation Opportunities

During the past century, no single force has had a greater impact on the pattern of land development in American cities than transportation. Improved roadways and affordable cars have enabled families to relocate from housing near their workplaces to homes in the suburbs that provided more housing per dollar in the form of larger lots, detached houses, and cleaner environments. In turn, retailers followed their customers to the suburbs. In turn, service-oriented firms followed the retail and manufacturing firms they serve to the suburbs. In short, transportation improvements have been a major factor in the exodus of households and businesses from urban areas to the suburbs.

If improvements and additions to transportation systems are designed with energy conservation in mind and implemented in conjunction with effective land use policies, substantial energy savings can be realized. Options for reducing transportation energy consumption include:

1. Shifting traffic to more efficient modes, by lowering the Btu per seat miles (from auto to buses, mass transit and human powered sources);

2. Increasing load factor, by raising the passenger mile per seat (carpooling and vanpooling);

3. Reducing demand, by reducing passenger miles (through land use planning, telecommunications and other methods);

4. Increasing energy conversion efficiency, by lowering the Btu per seat mile (smaller and more efficient vehicles); and

5. Improving use patterns, by lowering seat miles (traffic design and control).

Although residential development in Greenwood County has begun to shift outward into historically rural areas in recent years, a large percentage of the population remains within the urban and suburban area of the County. While Greenwood County residents on average enjoy the shortest commutes in the State, with a mean travel time to work of only 20.2 minutes, they are also highly dependent on the automobile for transportation. Nearly 82% of Greenwood commuters drive alone to work – the 8th highest percentage in the State – and slightly higher than the 79.4% of workers statewide who travel solo to work. More than 14% of Greenwood workers carpool to work – comparable to the State percentage of 14% but relatively low when compared to the other counties, ranking 30th out of the State's 46 counties. Slightly over 2% of Greenwood commuters walk to work, ranking 14th among South Carolina counties and reflecting a percentage very similar to the statewide average of 2.3%. Perhaps the most significant statistic related to travel to work is the use of public transportation within the County. Less than one tenth of a percent of Greenwood workers travel to work by taxi, which is the only form of public transportation available in the County. This is the lowest percentage of workers using public transportation in the State, though it is only seven tenths of a percent lower than the percentage of workers statewide that use public transportation.

Figure 10-49. Travel to Work for Workers 16 Years and Older, 2000
Greenwood County and South Carolina

	Greenwood County		South Carolina
Travel to Work	**Number**	**S.C. Rank**	**Number**
Mean Travel Time to Work (minutes)	20.2	1	24.3
Drove Alone	81.5%	8	79.4%
Carpooled by Car, Truck or Van	14.5%	30	14%
Walked	2.1%	14	2.3%
Public Transportation, Including Taxi	0.1%	46	0.8%

Source: Office of Research and Statistics, S.C. Budget and Control Board, 2002-2003 South Carolina Community Profiles.

While traffic congestion is not a serious problem in Greenwood County at present, there are some emerging areas of concern. In the 2000 "Thoroughfare Plan for Greenwood County," the SC Department of Transportation (SC DOT) indicated that portions of Emerald Road (S-236), S-100, SC 34, SC 10, SC 246, US 25/178 Bypass, and SC 72 Business will all experience capacity deficiencies (congestion) in coming years. The SC DOT also notes that an increase in vehicle miles traveled (VMT) is a major contributor to traffic congestion. VMT is calculated by multiplying Average Annual Daily Traffic (AADT) by the centerline road miles for an area. Increases in VMT in Greenwood County have been fairly consistent in recent years, with a 3% increase from 1998 to 1999 and a 2.9% increase from 1999 to 2000. Greenwood's percentage increase in VMT from 1998 to 1999 was consistent with the increase statewide and was a little higher than the state increase from 1999 to 2000. While the increase in VMT statewide remained consistent with previous years, from 2000 to 2001 Greenwood County experienced a decrease in VMT of 2.3%. SC DOT transportation planners attribute the decrease in VMT in Greenwood County to

reporting adjustments for local VMT numbers that resulted in lower VMT for many counties than in previous years. Also, the growth in VMT statewide was caused primarily by significant VMT increases in the high growth coastal counties in 2001, which overshadowed the decrease in VMT experience by most rural South Carolina counties in that same year.

Figure 10-50. Vehicle Miles Traveled, 1998-2001
Greenwood County and South Carolina

	1998	% Change 1998-99	1999	% Change 1999-00	2000	% Change 2000-01	2001
Greenwood County	1,536,308	*3.0%*	1,582,585	*2.9%*	1,629,222	*-2.3%*	1,592,025
South Carolina	117,467,863	*3.3%*	121,335,268	*1.8%*	123,515,325	*2.0%*	126,005,698

Source: Western Region, SC DOT, March 2003.

The US Energy Information Administration estimates that nearly 70% of the energy usage in the transportation sector is expended by passenger modes of travel. Automobiles are responsible for a large portion of the total energy used because they are very energy intensive. As shown in Table 49, travel by automobile or light truck consumes more energy per mile than all other modes of ground transportation except light rail systems. Local bus systems and vanpools use less than one-third the energy of automobiles and less than one-fifth the energy of light trucks. Energy savings are even more dramatic when compared to travel on foot or by bicycle. Bicycle travel uses 25 times less energy than automobile travel, while walking uses 9 times less energy. These energy savings are even more significant when you consider that walking and bicycling rely on energy produced by the human body – not fossil fuels. Additional energy savings can be realized per person when the mode of travel is capable of transporting larger numbers of people (buses or rail systems), or even when an automobile or light truck transports more than one person per trip.

Figure 10-51. Transportation Energy Intensity by Mode

Mode	Average Energy Intensity (Btu per mile traveled)
Bicycle	140
Pedestrian	400
Vanpool	600
Bus – Intercity	1,000
Motorcycle	2,300
Rail – Amtrack	2,500
Bus - Transit	3,400
Light Rail/Commuter	3,600
Automobile	3,600
Light Trucks	5,000

Source: Peter Miller and John Moffet, "The Price of Mobility: Uncovering the Hidden Costs of Transportation," 1992.

The fuel efficiency of passenger cars and trucks has improved substantially over the years. The *Energy Policy and Conservation Act of 1975* required passenger car and light truck manufacturers to meet corporate average fuel economy (CAFE) standards applied on a fleet-wide basis for each manufacturer. The CAFE standards, coupled with higher fuel prices in the 1970's and 1980's and environmental quality initiatives such as the *Clean Air Act Amendments of 1990*, contributed to an increased demand for fuel-efficient vehicles. In turn, the demand for more fuel-efficient vehicles spurred improvements in existing technologies and the development of new technologies. For example, using lighter-weight materials and reducing the size of vehicles led to lighter vehicles that consumed less fuel per mile. Improvements in engine technology were also substantial. Increasing the number of valves per cylinder resulted in increased performance from smaller, more fuel-efficient engines. Increasing the number of gears in manual and automatic transmissions allowed engines to operate at peak efficiency more of the time.

One of the most far-reaching improvements in engine technology concerned fuel injection, which was available but not widely used prior to the mid-1980's. Valued for its greater fuel economy, as well as for its ability to control carbon monoxide emissions and to improve engine performance, fuel injection technology began to penetrate the fleet during the 1980's, and it was improved to such an extent that after 1990 virtually all new light-duty vehicles were equipped with fuel injection instead of carburetors. By 1994, the trend toward the use of fuel injection rather than carburetors for fuel metering brought the share of residential vehicles using fuel injection to nearly half of the total residential fleet. This share will increase in future years as older vehicles are retired.

The introduction of alternative fuel vehicles (AFV) into the transportation sector has the potential to significantly impact energy use within a community. AFVs include any dedicated, flexible-fuel, or dual-fuel vehicle designed to operate on at least one alternative fuel. Alternative fuels are being used today in place of gasoline and diesel fuel made from petroleum. The US Department of Energy currently recognizes the following as alternative fuels – methanol and denatured ethanol as alcohol fuels, natural gas, liquefied petroleum gas, hydrogen, coal-derived liquid fuels, fuels derived from biological materials, electricity and solar energy. Use of these alternative fuels can help to reduce national dependence on imported petroleum and improve air quality. All of the alternative fuels reduce ozone-forming tailpipe emissions.

In March 2003, a telephone survey of local automobile dealerships was undertaken to estimate how many alternative fuel vehicles were operating within Greenwood County. The four major dealerships in Greenwood County were contacted, representing major manufacturers including Ford, Toyota, Nissan, Buick, GMC, and Daimler-Chrysler. Of the dealerships contacted, all but one indicated that they had not stocked or sold any alternative fuel vehicles to date. One dealership, Ballentine Ford Lincoln-Mercury Toyota, reported selling approximately 68 alternative fuel vehicles from 2000 to 2003, including models E85 FFV Ford Taurus, E85 FFV Explorer Sport and Ranger FFV. All of these vehicles operate on gasoline or E-85 ethanol, or any combination of the two fuels. The Ballentine dealership also sold approximately 12 hybrid vehicles – all Toyota Prius' – within the last 3 years. It is also possible that Greenwood County residents have gone outside of the County to purchase other alternative fuel vehicles from manufacturers such as Honda and Mazda or that some AFV's sold by the dealership were purchased by users outside the County – making it difficult to estimate how many of these vehicles are actually operating within the County.

Ethanol is a renewable resource fuel produced by fermenting and distilling starch crops that have been converted into simple sugars. Feedstocks for this fuel include corn, barley and wheat. Ethanol can also be produced from "cellulosic biomass" such as trees and grasses and is called bioethanol. Ethanol is most commonly used to increase octane and improve the emissions quality of gasoline. Higher blends of ethanol, specifically E85, are becoming increasingly available in certain regions of the United States. All of the major automobile manufacturers have models that can operate on E85, gasoline, or any mixture of the two.

Hybrid electric vehicles (HEVs) are powered by two energy sources – an energy conversion unit (such as a combustion engine or fuel cell) and an energy storage device (such as batteries or ultracapacitors). The energy conversion unit may be powered by gasoline, methanol, compressed natural gas, hydrogen, or other alternative fuels. The energy conversion unit on the Toyota Prius is powered by gasoline. Because the efficient gas engine and electric motor provide power for the car and recharge the car batteries, the Prius never has to be "plugged-in" to recharge. HEVs have the potential to be two to three times more fuel-efficient than conventional vehicles.

10.6.5.1 Street and Parking Design

The evolution of street design in the United States has primarily been a product of a growing population's increasing dependence on the automobile. As traffic volumes increased, road design standards were modified to make auto travel more safe and efficient, often at the expense of the character of residential areas. Standards required streets wide enough to accommodate increased traffic, turning radii large enough for service and emergency vehicles to negotiate cul-de-sacs, and T-configured intersections that minimized traffic conflicts. Traditional grid systems fell out of favor because they allowed through traffic on residential streets, and cul-de-sacs were encouraged because they prevented such through traffic. In

addition, parking standards were designed to accommodate the maximum number of automobiles needed for each land use category, with little consideration for shared parking, carpooling or alternative methods of travel, shift changes, number of employees, or the unique needs of individual businesses or industries.

It has become apparent that many of these practices, while providing solutions to some problems, have created many others. Unnecessarily wide streets encourage faster speeds, discourage walking or biking, increase the percentage of impervious surface, and increase ambient temperatures. Poor connectivity often restricts the viability of other transportation modes, making driving the most attractive travel option. Cul-de-sacs lengthen distances for travelers, discourage pedestrian travel, and make transit service more difficult to operate and use while placing an added financial burden on local governments that must provide emergency, safety and maintenance services. Wide intersections and the placement of sidewalks adjacent to travel lanes make negotiation by pedestrians and cyclists difficult. Expansive parking lots increase impervious surfaces, make walking prohibitive, increase ambient temperatures, and are often underutilized.

The problems associated with conventional street and parking design ultimately result in increased energy usage. Street design that encourages and enables alternative modes of travel not only saves energy, but can also enhance the overall character and livability of an area. Alternative means of transportation can be made safer and more attractive by redesigning streets and intersections within intensively developed areas to give equal priority to pedestrians, cyclists, buses and automobiles.

Substantial energy savings can also be realized by sizing streets to accommodate their use. Retaining higher speed street designs and capacities outside intensively developed neighborhoods and developments allows driving speeds to be sustained where they will not endanger residents. A system of interconnecting streets of varying designs can provide multiple routes that diffuse traffic congestion by keeping local traffic off regional roads and divert through traffic away from local streets.

Automobiles are most efficient when operated at steady, relatively low speeds (35-45 mph) with no stops. Optimizing the timing of existing signals and installing advanced control equipment can significantly reduce traffic congestion and fuel use. Conversely, increasing the number of stops and slow-downs or decreasing the average speed below optimal levels will increase energy consumption.

Steps can also be taken to make parking areas more energy-efficient. To avoid excessive parking requirements, realistic parking needs can be determined by more closely examining the needs of specific use categories. The incorporation of shared parking in mixed-use developments can reduce parking demand. Parking design and placement are also critical factors. Lots should be placed and configured to encourage, rather than discourage, pedestrian travel to nearby businesses or residences. The addition of trees and other landscaping features can reduce ambient temperatures in parking lots, in addition to making them more visually appealing for pedestrian use.

In conjunction with the SC Department of Transportation, a “Thoroughfare Plan” has been developed for Greenwood County and its municipalities that identifies current and future carrying capacities of all roadways. The Plan also identifies areas for new construction and expansion of existing facilities, with the goal of greatly reducing travel times. A priority list of upgrades has been developed that identifies actual costs for these facilities which will be used when monies become available. Level of service indicators are being used to model the actual travel patterns within the County.

10.6.5.2 Multi-modalism

Most modern development patterns maximize convenience and safety for the automobile driver, but not for the pedestrian or cyclist. Today’s suburban pedestrian must often travel a route five times longer than the direct distance to their destination.

Sensible development practices encourage people to use alternative modes of travel – biking, walking or using transit – by providing safe routes to destinations. Interconnected streets reduce distances between points and make destinations easily accessible by multiple methods of travel. Although the option of driving to a destination still exists, better connections make the choice of an alternative mode for shorter

trips much more appealing. In some commercial areas connections between adjacent buildings can be so poor that patrons are forced to return to their cars, drive back out to an arterial road, travel a few hundred feet to the adjacent parking lot and park again to reach a neighboring building.

For people to choose to walk or bike on neighborhood streets they must feel as welcome and safe as those who choose to drive. Streets designed with many different users in mind encourage non-vehicular travel. Without a comfortable and safe environment for all users, people will continue to rely on the car for trips to and from home. The key principle to follow in designing successful multi-modal road systems is balance – ensuring the safety and quality of the street environment for all users.

South Carolina's mild winters and moderate temperatures throughout most of the year make walking a popular activity among residents. There is substantial evidence that if safe and adequate facilities are provided, many people will choose to walk to work, to run errands, and to obtain personal services. In addition to safety factors, field studies have shown that the level of aesthetic interest is a critical factor in choosing a walking route. People are unwilling to walk farther than 300 feet through a parking lot to reach a desired destination, yet they will walk at least three times that distance along a street of storefronts.

Bikeways are most successful in reducing automobile travel in communities where development is compact and a mixture of land uses is encouraged. Although cycling for transportation and recreation is widespread, it is most popular in areas with relatively gentle terrain and in areas with a large student population such as a college or university. Bicycle paths should be physically separated from roadways whenever possible, and clearly marked by striping and signage when located adjacent to automobile travel lanes. Intersections and bridges should be designed to safely accommodate bicycle access where needed. To be effective, pedestrian walkways and bike paths should be continuous, linking areas and activities on the site and connecting to locations and paths adjacent to the site.

Most Greenwood residents commute by car because it is convenient and provides reliable on-demand, door-to-door service, usually in a timely manner. To be seen as a viable alternative to car travel, transit must provide a similar service. Many factors can encourage transit use, including traffic congestion, close proximity to home and work, ease of use, safety, reliability, timely delivery, and affordability. Transit systems are most convenient and yield the greatest energy and environmental benefits when a rider's origin and destination are located within walking distance of the transit station or stop. By placing more housing near existing and planned transit stations and stops, more people are likely to use transit and will walk to the station, rather than drive. It is just as critical for efficient provision of transit opportunities that work sites be located within walking distance of transit service. At present, there is no public transit system in Greenwood County.

The Greenwood City/County Planning Department staff has recently conducted a sidewalk inventory of every public street within the City limits of Greenwood. The inventory identifies the availability of pedestrian facilities and the current conditions of sidewalks. Using GIS, the staff has been able to identify where linkages are currently unavailable within the pedestrian pattern and where pedestrian traffic is hindered due to problem areas. The inventory will be used to develop a master pedestrian plan that outlines strategies for upgrades to existing facilities and development of new pathways.

10.6.5.3 Travel Alternatives

Advances in technology have resulted in new ways to reduce vehicular traffic and conserve energy. While 293 Greenwood County residents reported working in their home in 2000, improvements in communications and technology has the potential to produce significantly more home-based workers in the future. Many of these workers operate their own businesses from their homes. However, a growing number of companies are instituting telecommuting as an employment option for their employees. Telecommuting is a growing practice in which employees work at home and communicate with the office by telephone, computer and fax. Some telecommuters do all of their work from their home, while others work part of the week at home and part at their place of business. Each day an employee telecommutes or works at home eliminates at least one round trip.

Teleconferencing can also reduce work-related travel by removing the need to travel for meetings and training. Participants use telephone or video technology to hear and view other participants and to view

overhead slides or other materials. Computer modems, cable, and other technologies enable data and documents to be exchanged. The benefits of teleconferencing to employers include higher meeting attendance and increased participation, elimination of costly trips, less time away from the job for participants, and greater scheduling flexibility. These technologies can be utilized by individual companies, businesses, agencies, educational institutions, hospitals, and local governments. However, a more cost-effective way to encourage the incorporation of this technology into a wide range of operations is to develop community teleconferencing centers. Such facilities can be developed through public/private partnerships to include local government, universities and community colleges, K-12 schools, government agencies, community-based nonprofits, and private businesses and industries.

A number of public institutions and private enterprises within Greenwood County have teleconferencing capabilities including Piedmont Technical College, Upper Savannah Council of Governments, Self Regional Healthcare, Lander University, Capsugel/Pfizer, Fuji Photo Film, and the James Self Genetics Center. The potential for development of local partnerships and sharing of teleconferencing resources is very promising and should be explored along with the potential market for such facilities by other community groups and enterprises.

Many communities are also encouraging employers to develop work schedule strategies that will help to reduce traffic congestion. Traffic congestion leads to reduced travel speeds, which results in excessive energy consumption. Alternative work schedules can reduce traffic congestion and energy consumption by shifting commuters out of the peak travel periods and eliminating commute trips. With "compressed work weeks" employees work more than 8 hours a day for 4 days in order to take the fifth day off – resulting in the elimination of one round trip per week. "Flex-time" scheduling allows workers to set their schedules depending upon their needs, with certain core hours when they must be at work. "Staggered work hours" can be used to reduce peak congestion by staggering start times of employees. Both flex-time and staggered work hour programs can reduce the number of workers commuting during peak travel times, though such programs may interfere with ridesharing opportunities.

10.6.6 Land Use Planning Opportunities

The population of Greenwood County is steadily becoming more urban, with the rural population of the County dropping from 65.1% in 1990 to 44% in 2000. However, the rural population of the County in 2000 was significantly higher than the rural population statewide at 39.5% and the rural population nationwide at 21%. The County ranks 19th of the State's 46 counties in population but only 38th in land area, with a population density that is the 14th highest in the State at 145.5 persons per square mile. By comparison, population density statewide is substantially less at 133.2 persons per square mile.

As Greenwood County continues the transformation from a rural community to a more urbanized area, its land use policies and programs will have a profound impact on the community energy consumption rate. The Florida Center for Community Design and Research estimates that more than half of the energy use of industrialized countries is related to land use distribution – that is, to the spatial relationships of residences to work sites, schools, shopping and other activities. A variety of land use planning tools and methodologies have proven to be effective energy conservation measures. While some involve the development of new policies or regulations or the provision of incentives, others can be accomplished through revisions to existing procedures or regulations that address mixed-use and infill development, redevelopment of existing sites, full utilization of existing infrastructure, and compact development.

10.6.6.1 Mixed-Use Development

The location of stores, restaurants, offices, residences, schools, recreation areas, and jobs within close proximity lessens reliance on the car and encourages alternative modes of travel. Such "mixed-use" development results in greater independence of movement for non-drivers such as the young and the elderly and provides access to support service for the growing number of people who work at home. Residents under 16 years of age comprise 22% of Greenwood's population, while residents aged 65 and older make up 13.7% of the County population. It is estimated that 293 County residents work at home. Mixed-use development can also provide a variety of housing choices for a range of age groups, family types and income levels – contributing to a diverse and vibrant community.

Mixed-use developments that combine residential and commercial uses encourage pedestrian and bicycle travel both for shopping and to work, reducing personal vehicle trips. The length of trips by home-based workers to business services and suppliers can be shortened in developments that mix residential and commercial uses, allowing some of these to be made on foot or by bicycle. In addition, advances in technology have resulted in an increasing number of industries that produce no noxious smells or sounds, making them more compatible neighbors to both commercial and residential uses.

Developments that include employment centers, shopping and personal services can produce significant energy savings. With services such as convenience grocery stores, restaurants, dry cleaners, banks, post office and mail centers, childcare centers and pharmacies located near the workplace, commuters can take care of errands without driving elsewhere for these services.

Residential developments that include a mixture of housing densities and types are more energy efficient than conventional single-family housing developments. Including a variety of compact housing types including multi-family, townhouses or patio homes in a development can result in substantial savings in both energy for heating and cooling and in automobile-related energy use when compared with conventional single-family developments.

Building and site design are critical to the energy efficiency of mixed-use developments. Safe, attractive and convenient pathways should be provided that link residential, commercial and employment both within the site and with appropriate adjacent uses. To encourage walking within the development, parking for commercial uses should include a pedestrian circulation pattern that allows customers to park once and visit several locations on foot. It is also important to carefully balance considerations such as noise, aesthetics, and traffic impact to ensure that increased co-mingling of land uses is indeed beneficial to the community.

10.6.6.2 Infill and Redevelopment

Of all the sustainable growth strategies that can be undertaken in a region, strengthening existing, central urbanized areas is one of the most critical. Successful downtowns offer an attractive pedestrian environment, including a complementary mix of uses that generate activity throughout the day and into the evening. Revitalization efforts seek to maximize the use of available properties in urban areas, resulting in more productive use of these strategically located centers and reducing the need to convert greenfields into suburbs. However, healthy urban areas and suburbs are not mutually exclusive. In fact, a strong central city should have a positive effect on the whole region. By combining a mixture of uses, higher densities, efficient use of existing infrastructure, and multimodal transportation opportunities, urban areas play an important role in reducing per capita energy consumption.

The trend toward developing outward into traditionally rural areas impacts older suburbs as well. As growth extends past older suburbs, buildings are abandoned and often left to decay. A current example is the tendency of some “big box” retailers to abandon smaller, relatively new buildings and move to newer, larger facilities located even further from established areas. A successful community revitalization effort should address these older suburbs as well as the urban area.

Many residential neighborhoods and commercial areas, both old and new, have been under-built, leaving empty, overgrown and unkempt lots that create gaps between buildings. Though these vacant, abandoned or derelict properties in established residential and commercial areas often appear to be liabilities to the community, they provide prime opportunities for energy conservation. Infill development makes use of properties within established districts that were initially bypassed, created by demolition, or abandoned for new development. Infill developments contribute to energy conservation on multiple levels. Higher density infill developments promote travel alternatives such as walking and bicycling and help sustain nearby mixed-use development. Infill development also utilizes existing infrastructure, reducing the need to expend additional energy and funds in the expansion or construction of new support facilities.

Properties that include abandoned or derelict buildings are rarely thought of as desirable sites for new development, since the added demolition and cleanup costs often make redevelopment prohibitive. Redevelopment of such sites, known as brownfields or greyfields, is often complicated by the existence

of real or perceived environmental contamination. Brownfield redevelopment is a strategy for returning such lands to productive use that results in energy and financial savings as well as improved public and environmental health. Brownfield redevelopment contributes to the local economy and may also attract additional development to an underutilized area. As with infill development, redevelopment can decrease energy consumption and public cost by utilizing existing infrastructure and preventing further encroachment into greenfields.

Redevelopment also includes the innovative reuse of existing facilities. For instance, many "dead" retail malls have been converted into schools, churches, government facilities, offices and heath care facilities. Local adaptive reuse of older buildings has been particularly successful in the City of Greenwood, where a city block of old retail space was transformed into the Inn on the Square, an upscale hotel. Just down the street from the Inn, the former Greenwood High School was converted into the Greenwood High Apartments.

10.6.6.3 Compact Development and Clustering

The introduction and encouragement of compact development and clustering in a community can significantly impact energy usage. The fundamental concepts of compact development and clustering are similar, but distinct in application. *Clustering* is a development design technique that concentrates buildings in specific areas on a site to allow the remaining land to be used for recreation, common open space, or the preservation of historic or environmentally sensitive features. A *compact development* is one that is built at optimal density and does not necessarily include the provision of open space. Compact development concepts are generally used within cluster projects to maximize buildable space and ensure the adequate provision of open space.

While the concepts of compact development and clustering can be applied to commercial or industrial projects, they are most often associated with residential development. Compact residential development can be achieved by building homes on smaller lots, incorporating provisions for zero-lot-line design (patio homes), building attached homes (duplexes or townhouses), or building multi-family structures (apartment buildings). Clustering is best suited for suburban or rural areas where there are available properties of adequate size to accommodate the required open space. Compact development is best applied to projects in urban areas where properties are generally too small to include significant amounts of open space.

When compared with conventional subdivisions, compact and cluster developments are more energy-efficient. Compact development shortens trips, lessening dependence on the automobile and thereby reducing levels of fuel consumption and air pollution. Residential clustering can reduce the length of streets and utility line installations, saving energy in the construction and later in the maintenance of streets, the transmission of electricity and water, and the provision of services including garbage collection in both compact and cluster developments. In addition, the increased vegetation and open space preserved in cluster developments contribute to a reduction in summer air temperature and cooling needs.

The smaller detached single-family, attached single-family and multi-family homes characteristic of compact development use less energy for space heating and cooling than traditional single-family detached homes. Shared walls in attached and multi-family units reduce heating and cooling losses, resulting in even greater energy efficiency. Compact developments also make more efficient use of urban services by accommodating more residents in less space than typical subdivision design.

Locally, the Joint Planning Commission of Greenwood County is currently working with the Greenwood City and County Councils on a revised zoning ordinance that includes an allowance for cluster developments. This proactive approach allows residential development to cluster all the density in one area of the property while leaving the remaining area undisturbed. Essentially, the developer is given an option to transfer the allowable densities of the entire property into a smaller portion with more dense development to save on infrastructure costs as well as leave the remainder of the property undisturbed.

10.7 Local Renewable Resources Potential

As dependence on conveniences such as cars, air conditioning and computers grows, the continued search for alternatives to the nonrenewable fuel sources which we are rapidly depleting becomes more critical. The energy that powers such conveniences is generated primarily by coal, oil, natural gas or nuclear energy. As nonrenewable resources, the supplies of coal, oil and natural gas are finite and can be exhausted in the course of time. In addition, the byproducts of these resources, such as carbon dioxide and carbon monoxide, contribute to the degradation of the atmosphere and environment. The use of nuclear energy presents problems as well, in particular the containment of the toxic waste byproducts and the extremely long half-life and costly storage requirements of uranium.

The use of renewable energy sources reduces dependence on imported energy. A renewable resource is a natural, but flow-limited, resource that can be replenished. Such resources are virtually inexhaustible in duration, but limited in the amount of energy that is available per unit of time. Some (such as geothermal and biomass) may be stock-limited in that quantities are depleted by use, but on a time scale of decades or perhaps centuries, they can be replenished. Renewable resources such as sunlight, geothermal, water and wind are not at-risk for depletion, although the cost and the rate at which the resource is used are often crucial factors in its long-term viability. Despite some constraints in the use of these renewable resources, they hold the most promise for cleaner, more efficient energy production.

In a time of continued political and economic uncertainty and growing conflict in areas of the world that have historically been key providers of oil, it is crucial that communities seek ways to reduce dependence on imported energy. Developing local renewable resources such as geothermal, solar and biomass will reduce the need to import non-renewable supplies, thus strengthening and adding stability to the local economy. Such efforts will also lessen the Greenwood community's vulnerability to outside supply disruptions and price fluctuations.

Scientists have been working to develop renewable resources that can be used for large-scale applications such as powering cars and heating and cooling buildings. There are many sources of renewable energy available nationwide, although due to geography and climate some of those sources are not applicable to the Greenwood County region. The prevailing winds in South Carolina are not sufficiently sustained or of enough force to make the use of wind generation viable. Although hydroelectric power is used throughout the State to generate energy, development of new hydroelectric sources is usually not feasible, given the prohibitive costs for facility construction and increased environmental concerns and regulations. Generation of energy through geothermal wells is possible in the western United States due to the proximity of magma close to the earth's surface, however this is not the case in the southern region of the country. Given geographic conditions and environmental constraints, the most feasible renewable energy alternatives for the Greenwood region are solar, biomass, and geothermal energy.

10.7.1 Solar Energy

Photovoltaic (PV) cells convert sunlight, the world's most abundant energy source, into electricity, one of the most versatile forms of energy. The term "photo" comes from the Greek "phos," which means "light" and the term "voltaic" meaning voltage. Most commonly known as "solar cells," PV systems are already an important part of our lives. The simplest systems power many of the small calculators and wrist watches we use every day, while more complex systems can light houses and provide power to the electrical grid. According to the SC Energy Office, photovoltaic cells have the potential to be one of the most useful of the renewable energy technologies.

Photovoltaic (solar) cells absorb sunlight and convert it directly into electricity – without the use of any moving parts. Most solar cells today are made from single crystal silicon. A thin wafer is sliced and electrical contacts are made to the two sides of the wafer. When sunlight (specifically, photons of energy) penetrates the surface of the wafer or cell, electrons are released which can flow through the electrical contacts to a load. The SCEO reports that with present technology, the efficiency of conversion of sunlight to electricity directly at the cell is about 12 to 15 percent and the reliability of the units is very high. With protection from mechanical damage and thermal shock, the lifetime of the units can extend several decades. For example, solar powered space satellites have demonstrated very high reliability over periods well in excess of fifteen years.

Since individual cells produce only a small amount of electricity, cells are linked together in solar arrays to produce large amounts of electricity. Cells or arrays are mounted on a roof or on platforms to maximize exposure to the sunlight. The photovoltaic cell produces a direct current, which can be used to operate motors and lights or to maintain the charge in a storage battery so that power can be available during periods when sunlight is not present.

Solar cells now power virtually all satellites, including those for defense, scientific research, and telecommunications. Solar electricity is now relied on when making long distance calls or watching television via satellite communication systems. PV cells are also currently used in remote areas for communication, water pumping, desalination, and lighting. Present uses for PV systems only hint at the ultimate potential of this energy source. In the US and other urbanized countries they can be mounted on house rooftops to generate power, which will reduce power purchased from the utility and supplement the grid through sales of excess electricity to the utility. Photovoltaics may also be installed by utility companies for use as central power generating stations.

10.7.2 Energy from Biomass

Biomass fuels are energy sources from recent-term organic (plant and animal) matter. Examples of biomass sources are trees, farm crops (such as ethanol from corn), manure, plants and landfill gas. While wood is one of the most plentiful forms of biomass energy, trees can take from 10 to 20 years to become large enough to use – making sound forestry management essential to the viability of this resource. Wood waste (sawdust, shavings, bark and black liquor) can also be used to generate electricity. In fact, the largest source of energy from wood is pulping liquor or “black liquor,” a waste product from processes of the pulp, paper and paperboard industry.

The Trigen Biopower-Greenwood Plant in Hodges uses mountains of wood residue and fuel derived from tires to produce steam daily. The plant sells all the steam to the National Textile facility, located next door. On average, the biopower plant burns 9 tons of wood chips and 0.18 tons of tire chips per hour, thus diverting it from the local landfill where it would eventually decompose and produce carbon dioxide.

Grain crops such as corn and wheat can be processed into alcohol fuels. Ethanol is an alcohol-based alternative fuel produced by fermenting and distilling starch crops that have been converted into simple sugars. Feedstocks for ethanol include corn, barley and wheat, and bioethanol can also be produced from "cellulosic biomass" such as trees and grasses. Ethanol is most commonly used to increase octane and improve the emissions quality of gasoline. Most major automobile manufacturers produce at least one vehicle that is capable of running on a mixture of ethanol and gasoline.

The methane gas derived from animal and human waste using an anaerobic digester is a viable and attractive fuel source. Methane gas can be used either in an internal combustion engine to produce electricity or to assist in co-firing a boiler or heat exchanger system. In some instances the gas is bottled and used to fuel farm equipment.

Municipal solid waste (MSW) landfills are also promising sources of methane. According to the Energy Information Administration, each person in the United States generates almost a ton of waste per year, most of which is deposited in solid waste landfills. Landfill gas (LFG) is created when waste in a landfill decomposes. It is about 50 percent methane, a potent greenhouse gas, and 45 percent carbon dioxide. Instead of allowing landfill gas to escape into the air, the gas can be captured, converted, and used as an energy source. Using the gas helps to reduce odors and other hazards associated with LFG emissions, and it helps prevent methane from migrating into the atmosphere and contributing to local smog and global climate change. Information provided by the SCEO indicates that the amount of landfill gas produced in the 750 nationwide landfills would provide, if captured, enough energy to power 3 million homes. Landfill gas can be recovered by direct heating, electricity generation, chemical feedstock, purification to pipeline-quality gas, and heat recovery. The methane recovered through these methods can be used to fire industrial boilers, heat and cool residential and industrial spaces, fuel gas and steam engines, power fuel cells, and to power vehicles through conversion to either methanol or diesel fuel.

Greenwood County is currently studying the feasibility of harnessing, processing and distributing methane gas from its landfill site for energy production. The production of energy from landfill gas requires the use of contained landfill areas. The Greenwood County Municipal Solid Waste Landfill site is approved for 8 cells, or contained landfill areas, within the 115-acre site. *Cell 1* is approximately 20 acres and has recently been closed. *Cell 2* has been constructed and approved by the South Carolina Department of Health and Environmental Control (SC DHEC), with the remaining cells to be developed in future years. Because landfill gas (LFG) poses an explosive danger, an odor nuisance, and a health hazard, SC DHEC requires landfill controls to prevent the migration of methane gas emissions. Greenwood County currently uses a flare system to burn off the methane and other landfill gases generated by closed cells to prevent their escape into the atmosphere.

However, the County also has the option of collecting LFG and converting it to energy. The County's ultimate goal is to harness this naturally occurring energy and convert it into a usable product – whether to provide electricity to County facilities located at the landfill or to produce energy for sale to local residences, businesses, and industry. Local industries have shown preliminary interest in exploring this energy generation alternative if it proves to be cost-effective.

10.7.3 Geothermal Energy

Geothermal energy is the heat from beneath the Earth's surface, with resources ranging from shallow ground to hot water and hot rock found a few miles beneath the Earth's surface, and down even deeper to the extremely high temperatures of molten rock called magma. In South Carolina, geothermal heat pumps that require only moderate ground temperatures use the earth's moderate, relatively constant temperature (ranging from 60E to 70EF) to provide heating and cooling year round.

Geothermal heat pumps (GHP) are among the most efficient and comfortable heating and cooling technologies available, requiring no supplemental heat source because of the moderate temperature of the ground even in winter. According to the SCEO, the energy value of the heat removed is usually more than three to four times the electricity used in the transfer process.

A GHP system consists of a heat pump, an air delivery system (ductwork), and a heat exchanger consisting of a system of pipes buried in the ground near the building. Most systems in South Carolina are vertical loop installations with a typical depth of 200 feet. In the winter, the heat pump removes heat from the heat exchanger and pumps it into the indoor air delivery system. In the summer, the process is reversed, and the heat pump moves heat from the indoor air into the heat exchanger. The heat removed from the indoor air during the summer can also be used to heat water, providing a free source of hot water.

10.7.4 Thermal Energy Storage

Ice has long been used for space comfort conditioning. In the early nineteenth century, ice was placed in air ducts to cool and dehumidify warm air blown by fans. The use of ice for cooling has evolved a great deal since that time, with modern thermal storage systems utilizing mechanical refrigeration (called chillers) to make ice at times when electric rates are lower – primarily at night. The ice is stored and when cooling is needed water is circulated through the ice storage area and then distributed to provide space cooling. Thermal energy storage supplements and in some instances even replaces mechanical cooling during the day when utility rates are at their highest. Depending on the situation and type of installation, ice storage can cut electric costs dramatically. Ice storage has the potential to reduce both system demand and overall energy costs for many types of structures including large buildings and public facilities.

An additional advantage of ice storage is the standby cooling capacity available if the chiller is unable to operate for any reason. In those cases one or two days of ice may still be available to provide cooling until the chiller is operational once again.

Thermal energy storage systems not only save energy and money, they also conserve resources through the filtration and reuse of the water used in the systems.

Goals, Objectives, and Strategies for Implementation

Goals/Objectives/Strategies	Accountable Agency	Time Frame for Completion
Goal 10.1. – Promote energy conservation through environmentally beneficial actions		
Objective 10.1.1. Encourage the use of trees and landscaping to conserve energy		
Strategy 10.1.1.1. Encourage the use of trees and landscaping to conserve energy	Planning Commission	2007
Strategy 10.1.1.2. Revise development standards to encourage landscaping, including trees	Planning Commission	2007
Strategy 10.1.1.3. Revise development standards to encourage proper maintenance for landscaping and trees	Planning Commission	2007
Strategy 10.1.1.4. Work with civic groups to educate the public on the energy benefits of trees, landscaping and proper maintenance	SC Forestry Commission	On-going
Strategy 10.1.1.5. Continue to use services of urban foresters	City of Greenwood	On-going
Strategy 10.1.1.6. Work with civic groups to plant trees and other vegetation in developed areas	Forestry Commission	On-going
Objective 10.1.2. Provide and encourage open spaces		
Strategy 10.1.2.1. Revise development standards to encourage provision of open space in new developments	Planning Commission	2008
Strategy 10.1.2.2. Revise development standards to encourage developers to link new opens spaces and greenways to existing greenways	Planning Commission	2008
Strategy 10.1.2.3. Update the Community Greenway Plan and add an Open Space Plan	Planning Commission	2012
Strategy 10.1.2.4. Develop programs to fund land purchases for greenways and seek conservation easements from property owners	Upper Savannah Land Trust	On-going
Strategy 10.1.2.5. Designate potential open space in developed areas and seek funding for their purchase	Parks Commission	On-going
Objective 10.1.3. Use and encourage the use of alternative fuels		
Strategy 10.1.3.1. Work with civic groups and other levels of government to promote the use of alternative fuels	Greenwood County	2008
Strategy 10.1.3.2. Educate the public on the availability and benefits of alternative fuels	Greenwood County	2008
Strategy 10.1.3.3. Incorporate the use of alternative fuels into local government and institutional operations	EPAC	2009
Strategy 10.1.3.4. Work with civic groups and other levels of government to seek funding such as grants or loan programs for incentive programs	Greenwood County	2009
Strategy 10.1.3.5. Study the potential of converting waste byproducts into energy for industrial use	Greenwood County	2009
Strategy 10.1.3.6. Continue to measure methane production levels at the landfill as the cells are closed	Greenwood County	On-going
Objective 10.1.4. Encourage recycling		
Strategy 10.1.4.1. Continue to work with civic groups to educate the public on the benefits of recycling	County Recycling	On-going
Strategy 10.1.4.2. Revise development standards to encourage recycling and implement adequate enforcement at recycling centers	County Recycling	2009
Strategy 10.1.4.3. Continue to work with local businesses and industries to encourage recycling in the private sector	County Recycling	On-going

Goals/Objectives/Strategies	Accountable Agency	Time Frame for Completion
Goal 10.1. – Promote energy conservation through environmentally beneficial actions		
Objective 10.1.4. Encourage recycling		
Strategy 10.1.4.4. Continue to develop recycling centers and determine locations based on current and potential population growth	County Public Works	On-going
Strategy 10.1.4.5. Study recycling process and state placement to determine best practices and plan for new services	County Public Works	2009
Strategy 10.1.4.6. Revise development standards to encourage new development to include proper space and access to recycling areas	Planning Commission	2008
Strategy 10.1.4.7. Make recycling more convenient for small businesses	County Recycling	On-going
Strategy 10.1.4.8. Develop an Uptown convenience recycling site for small businesses	Uptown Greenwood Development Corporation	2009
Goal 10.2. – Promote energy conservation through economic development		
Objective 10.2.1. Recruit and retain businesses and industries with energy conservation in mind		
Strategy 10.2.1.1. Continue to work with local economic developers to link the Comprehensive Plan and economic development goals and objectives	Planning Commission	On-going
Strategy 10.2.1.2. Continue to contribute to consideration of local sustainability when evaluating industrial and business prospects	Economic Alliance	On-going
Strategy 10.2.1.3. Continue to develop strategies for recruiting industries that contribute to local energy conservation efforts	Economic Alliance	On-going
Strategy 10.2.1.4. Continue to develop strategies for recruiting and retaining small businesses and industries	Economic Alliance	On-going
Objective 10.2.2. Revitalize existing facilities and districts and promote infill development		
Strategy 10.2.2.1. Continue to focus economic development efforts on the reuse of existing properties and the use of infill properties	Economic Alliance	On-going
Strategy 10.2.2.2. Continue to develop detailed inventories of vacant, underutilized and available commercial and industrial properties	Economic Alliance	On-going
Strategy 10.2.2.3. Continue to develop incentives to locating in existing facilities on infill properties such as tax or fee reductions	Economic Alliance	On-going
Strategy 10.2.2.4. Continue to work with local developers, realtors and economic developers to develop promotional materials for revitalization	Economic Alliance	On-going
Strategy 10.2.2.5. Continue to seek funding for brownfield reclamation	Economic Alliance	On-going
Strategy 10.2.2.6. Continue to work with economic developers to develop promotional materials on successful brownfield redevelopments	Economic Alliance	On-going
Strategy 10.2.2.7. Continue to facilitate regulatory flexibility in redevelopment	Planning Commission	On-going
Objective 10.2.3. Promote the production of economically valuable good and services		
Strategy 10.2.3.1. Encourage the development of industrial parks that reduce waste, promote recycling and energy efficiency, and have a minimal impact on the environment	Economic Alliance	2009
Objective 10.2.4. Encourage the use of renewable energy and recycling in business and industry		
Strategy 10.2.4.1. Facilitate the development of partnerships to encourage the use of renewable energy sources	Greater Greenwood Chamber of Commerce	2009
Strategy 10.2.4.2. Seek funding for the implementation of renewable resource programs	Greenwood County	2009
Strategy 10.2.4.3. Facilitate local and regional eco-industrial recycling partnerships for waste by-product incorporation into industrial production processes and energy generation	Greenwood County	2009

Goals/Objectives/Strategies	Accountable Agency	Time Frame for Completion
Goal 10.2. – Promote energy conservation through economic development		
Objective 10.2.5. Encourage incorporation of energy conservation measures into construction and design		
Strategy 10.2.5.1. Assist businesses and industry with identification of funding assistance for upgrades, retrofits, and new technology demonstration	Economic Alliance	2009
Strategy 10.2.5.2. Educate employers on Long-Term savings from energy efficient investments	Greater Greenwood Chamber of Commerce	2009
Strategy 10.2.5.3. Establish partnerships with local utilities to develop energy efficiency and conservation programs	CPW/Duke Power	2009
Strategy 10.2.5.4. Sponsor workshops on energy conservation practices and conduct energy audits for commercial and industrial facilities	CPW/Duke Power	2009
Strategy 10.2.5.5. Partner with employers and utility providers to build demonstration facilities to showcase energy-efficient design principles	CPW/Duke Power	2010
Objective 10.2.6. Promote energy conservation in the regulation process and provide incentives for conservation		
Strategy 10.2.6.1. Streamline development standards and approval processes and allow flexibility for new technologies and innovations	Planning Commission	2008
Strategy 10.2.6.2. Link economic development efforts with the goals and objectives of the Comprehensive Plan	Planning Commission	2008
Strategy 10.2.6.3. Coordinate closely with economic developers in planning and development matters	Planning Commission	On-going
Strategy 10.2.6.4. Pursue federal and state funding opportunities for pilot projects and development of new energy technologies and products	Lander University/Piedmont Technical College	2010
Strategy 10.2.6.5. Involve local business and industry representatives in the energy conservation planning process	EPAC	On-going
Strategy 10.2.6.6. Continue to monitor existing financial incentives to maintain financial attractiveness	Greenwood County	On-going
Strategy 10.2.6.7. Identify and secure tax breaks, loans, financing, infrastructure grants and other incentives for energy conservation	Greenwood County	2010
Goal 10.3. – Reduce residential energy use		
Objective 10.3.1. Promote energy conservation through housing design, materials and landscaping		
Strategy 10.3.1.1. Revise development standards to encourage compact development and mixed use development	Planning Commission	2007
Strategy 10.3.1.2. Continue to work with local civic groups and utilities to seek funding for weatherization programs and to educate the public on benefits of making homes more energy efficient	Upper Savannah COG	On-going
Strategy 10.3.1.3. Continue to work with the building industry to educate their members about the benefits of energy efficient development and construction	City/County Building Inspection	On-going
Strategy 10.3.1.4. Continue to work with local civic groups and utilities to educate the public on the benefits on energy efficient heating and cooling units, water heaters, and other appliances	City/County Building Inspection	On-going
Strategy 10.3.1.5. Promote Duke Power's Home Energy Analysis Program as a way for homeowners to conserve energy	City/County Building Inspection	2009
Goal 10.4. – Reduce energy used in community facilities		
Objective 10.4.1. Promote energy conservation through administrative procedures, policy changes and education		
Strategy 10.4.1.1. Develop and implement a comprehensive energy conservation program	Greenwood County	2010

Goals/Objectives/Strategies	Accountable Agency	Time Frame for Completion
Goal 10.4. – Reduce energy used in community facilities		
Objective 10.4.2. Consider energy conservation when determining the location of new facilities		
Strategy 10.4.2.1. When possible, locate new facilities near bicycle and pedestrian facilities	Greenwood City/County Planning Department	2008
Strategy 10.4.2.2. When possible, locate new facilities near related uses	Greenwood City/County Planning Department	2008
Strategy 10.4.2.3. When possible, locate new facilities near essential services such as childcare, restaurants, etc.	Greenwood City/County Planning Department	2008
Strategy 10.4.2.4. Work with school districts and other state and federal agencies to encourage compliance with local development and construction requirements	Planning Commission	2007
Strategy 10.4.2.5. Work with school districts and other state and federal agencies to encourage consideration of energy use impacts when siting new facilities	Planning Commission	2007
Goal 10.5. – Reduce energy used for transportation		
Objective 10.5.1. Reduce energy use through street and parking design		
Strategy 10.5.1.1. Revise development standards to size street widths relative to their use and to allow smaller turnaround radii	Planning Commission	2008
Strategy 10.5.1.2. Encourage connected street systems within and between developments	Planning Commission	2008
Strategy 10.5.1.3. Encourage pedestrian protection measures at intersections	Planning Commission	2008
Strategy 10.5.1.4. Discourage the use of cul-de-sacs in developments	Planning Commission	2008
Strategy 10.5.1.5. Develop parking standards that address the realistic needs of different land uses and incorporate shared parking	Planning Commission	2007
Strategy 10.5.1.6. Include provisions for safe and convenient pedestrian and bicycle travel in street and parking design standards	Planning Commission	2007
Strategy 10.5.1.7. Incorporate traffic signal optimization	SCDOT, City/County Engineering	2009
Strategy 10.5.1.8. Encourage connection between parking areas within adjacent development when possible	Planning Commission	2008
Objective 10.5.2. Provide a multi-modal transportation system		
Strategy 10.5.2.1. Encourage integration of alternative modes of transportation in new developments	Planning Commission	2008
Strategy 10.5.2.2. Include provisions for safe, convenient and attractive pedestrian and bicycle paths in all new developments	Planning Commission	2008
Strategy 10.5.2.3. Encourage new development to include pedestrian and bicycle paths that connect to existing developments and destinations	Planning Commission	2008
Strategy 10.5.2.4. Encourage the continued study by regional and local governmental entities of the need for a transit system and evaluate transit as an alternative mode within the long range transportation plan	Upper Savannah COG	On-going
Strategy 10.5.2.5. Study the feasibility of adding a ride share facility for residents that travel outside of the County for employment	Upper Savannah COG	2011
Objective 10.5.3. Provide and promote travel alternatives		
Strategy 10.5.3.1. Revise development standards to encourage telecommuting and home occupations	Planning Commission	2007

Goals/Objectives/Strategies	Accountable Agency	Time Frame for Completion
Goal 10.5. – Reduce energy used for transportation		
Objective 10.5.3. Provide and promote travel alternatives		
Strategy 10.5.3.2. Explore the development of partnerships to enable the use of existing teleconferencing facilities	Greater Greenwood Area Chamber of Commerce	2011
Strategy 10.5.3.3. Explore enhancements to teleconferencing facilities that would ensure usability by all partners	Greater Greenwood Area Chamber of Commerce	2011
Goal 10.6. – Conserve energy through land use planning		
Objective 10.6.1. Encourage mixed use development		
Strategy 10.6.1.1. Revise development standards to allow mixed-use development in appropriate areas	Planning Commission	2007
Strategy 10.6.1.2. Develop incentives for mixed use development	Planning Commission	2007
Strategy 10.6.1.3. Allow home occupations	Planning Commission	2007
Strategy 10.6.1.4. Allow accessory housing units	Planning Commission	2007
Strategy 10.6.1.5. Allow 2nd story housing in Uptown Greenwood	Planning Commission	2007
Strategy 10.6.1.6. Encourage housing in/near large-scale commercial developments	Planning Commission	2010
Strategy 10.6.1.7. Encourage affordable housing near large employers	Planning Commission	2010
Strategy 10.6.1.8. Develop incentives for the inclusion of pedestrian and bicycle paths linking destinations within mixed-use developments and adjacent areas	Planning Commission	209
Strategy 10.6.1.9. Streamline review and variance procedures	Planning Department Staff	2007
Objective 10.6.2. Encourage infill and redevelopment		
Strategy 10.6.2.1. Revise development standards to allow infill and redevelopment as a permitted use whenever possible	Planning Commission	208
Strategy 10.6.2.2. Streamline review and variance procedures	Greenwood City/County Planning Department	2007
Strategy 10.6.2.3. Develop brownfield policies and procedures	Economic Alliance	2011
Strategy 10.6.2.4. Provide tax incentives and fee reductions to development for infill and redevelopment projects	Greenwood County	2010
Objective 10.6.3. Encourage compact development and clustering		
Strategy 10.6.3.1. Revise development standards to allow compact development and clustering where appropriate and as a permitted use whenever possible	Planning Commission	2008
Strategy 10.6.3.2. Allow accessory housing units	Planning Commission	2007
Strategy 10.6.3.3. Work with realtors and the development community to educate the public on the advantage of higher density developments	Planning Commission	2010
Strategy 10.6.3.4. Incorporate flexible design standards	Planning Commission	2007
Strategy 10.6.3.5. Provide tax incentives and fee reductions to developers of compact or cluster development projects	Greenwood County	2010